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GREENLAND—ARCTIC WONDERLAND*

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Never before has an event in human affairs scattered American citizens to the far corners of the globe as did World War II, and its aftermath. Americans found themselves in many strange and remote places doing their part in the big job of winning the peace. Our personal small part of the big job took us to Greenland where Bob spent four years as Safety Engineer for the air base located on the southern tip of the Island and Dorothy served in the capacity of teacher in the USAF School, also located at the air base.

When the telegram arrived from Washington announcing our assignment to Greenland we had only a very vague idea of what to expect from life in that formidable arctic waste. Visions of igloos inhabited by roly-poly Eskimos, dog sleds mushing through the snow, haggard men battling blinding blizzards, polar bears, seals, and possibly herds of reindeer with "red noses" were conjured up in our minds. We were elated over going, and at the same time a little apprehensive at the prospect of spending part of our lives in what we felt sure must be the world's largest out-of-doors "deep freeze." Considerable time had elapsed since either of us had studied about Greenland in school, so as a quick refresher course during the short time remaining before departure, much time was spent in the public library pouring over the World Almanac, encyclopedias and other available reference books on the Arctic. Our diligent search revealed only very meager information; mostly facts and figures concerning the population, geographical area, government and climate of our future home. As we embarked at Westover Field, Massachusetts on the big four-engine Air Force C-54 Skymaster, bound for Greenland,

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we knew in a small way how Columbus or Magellan must have felt as they sailed away into the unknown. We were sure of only one thing —we did not expect Santa Claus to be a member of the reception committee at our destination.

On our arrival we were delightfully surprised to find Greenland quite different from the visions conjured up in our minds, it was certainly much less inhospitable than we had expected it to be. During the next four years we had the opportunity of learning much about this strange land as we lived and worked there and gradually became a part of the community life.

Next to Antarctica, Greenland has the most extensive ice cap in the world to-day. It is more hospitable than Antarctica but it is, at that, a grim host who limits the activities of man chiefly to a scoured and bowlder-strewn fifty-miles-wide fringe, where even plant life has barely established a beachhead. Looking at this largest island in the world on the map the shape resembles roughly that of South America. It is approximately 1300 miles from north to south, and nearly 750 miles from east to west at the widest point. The total area is approximately 830,000 square miles, of which 700,000 square miles is covered with an ice cap. This cap ranges in thickness from 50 feet at the outer fringe to nearly 10,000 feet near the center. It has been estimated that if all ice in the great cap should suddenly melt, the water released would raise the level of all oceans in the world between 20 and 25 feet. There is, however, no need for alarm among dwellers on coastal plains, for there is no indication this is likely to happen in any predictable future. It will no doubt be in place there for some time to come.

To quote a few interesting facts about the Greenland ice cap from a booklet locally prepared. We read, "The total mass of this great glacier is greater than the total land mass of the European continent. At the periphery the ice cap is rugged, in great jagged peaks. However, after the first 30 or 40 miles the ice is not so rough but becomes rather smooth and rises to an elevation of approximately 10,000 feet. Lowest reported temperature on the face of the cap was minus 85 degrees Fahrenheit. Violent storms rage across the inland ice cap during the winter months, and in the summer great streams and lakes form on its face and disappear in a matter of days. They form from the melting ice and disappear through the deep crevasses which appear from time to time."

The ice-free belt extends 50 to 100 miles inland. Steep, jagged mountains form sheer-perpendicular walls down to the sea; innumerable fjords extend inland between the rugged mountains. Tongues of the great ice cap extend down the fjords and disgorge icebergs into the sea where they float down into the North Atlantic sea lanes. The

countryside is dotted with lakes and rivers. Even though the landscape is somewhat bleak it is not devoid of beauty. It is the grand beauty of a wild and rugged land, a landscape in the making.

Historically speaking, Greenland is probably the first real estate promotion enterprise on record. In 982 A.D. Eric the Red sailed from Iceland, landed on Greenland and lived there for three years. Then he returned to Norway with the idea of promoting interest in the new land. To make this rugged country appear more attractive, he named it Greenland. Apparently he attained a measure of success, for in 985 two colonies were established in the southwestern section with a population of 300 persons. Colonizing of Greenland is associated with very unusual circumstances which are so fantastic that one is inclined to consider them fairy tales. The Island was discovered in 974, colonies were established, and by 1261 trade and communication with Norway were perfected. Then contact with Europe closed in 1460, when three to 10,000 colonists lived on the Island. Then followed several centuries of Greenland as a forgotten land. Modern history of Greenland did not begin until the middle of the 18th century. During the hiatus of nearly 300 years the early colonists vanished and only the ruins of their villages witness to their life on Greenland. Their disappearance is still an unsolved mystery.

In the middle of the 18th century the Danish Government assumed control of the administration of the Island. Since that time steady progress has been made in both colonization and welfare of the native population. This has been achieved through well-founded policies and excellent long range planning. The native population now numbers approximately 21,000 persons. Small villages dot the coast line at intervals from Thule on the extreme northwest coast around the point of the Island and up the east coast. It is most densely populated in the southern portion below the Arctic Circle. Godhaab is the capital. It can boast of a 1500 population, which by the standards of this outpost land is quite a metropolis. Most of the villages are very small, numbering on the average 75 persons.

Plants and Animals of Greenland

Plant life shows the rigorous climate, tall trees are still wanting. Shrub-like willows and birches are the "giants" of the Greenland plant life. The landscape is most conspicuous by its bareness. Here and there moss blankets may cover the bare rocks and tint them a faint green, and tiny lavender and pink flowers huddle among the mosses. Animal life is represented by both water and land forms. The waters of the fjords abound in many kinds of fish. Among them are cod, trout, sharks, flounder, arctic char and the odd-shaped "sea robber." The largest sea animal is, of course, the whale. The muskox

can lay claim to being the largest land animal. There are also arctic fox, arctic hare, seal, walrus. Among the birds are found the raven, ducks, geese, gray falcon, ptarmigan, snowbird and the world's champion traveler, the arctic tern. The representatives of the insects are bumblebees, flies, spiders, and mosquitoes. Greenland has no snakes, ground hogs, squirrels, or chipmunks. The ptarmigan is without doubt the favorite game bird.

Spring Comes to Greenland

Spring is a welcome season in all temperate climates but it is doubly welcome in the Arctic. The long night is passing and the first angled rays of the sun are heralded with joy. The return of the sun

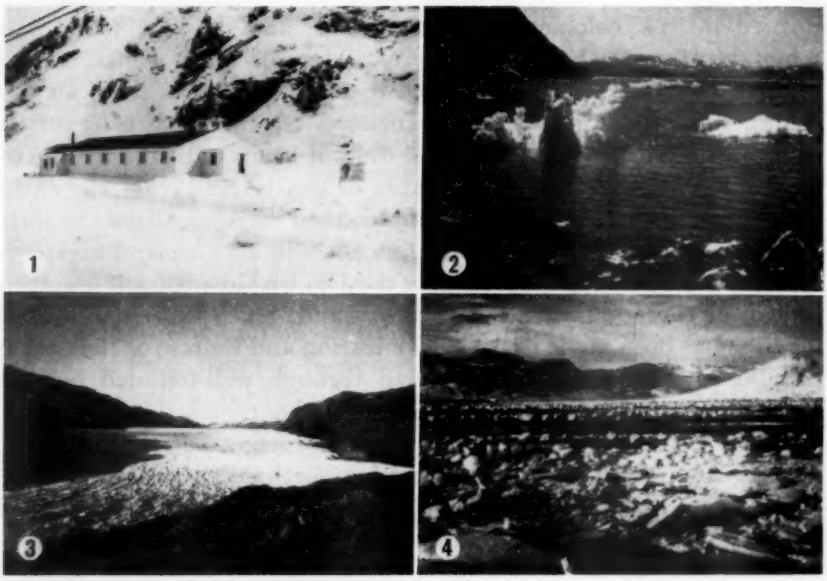

Fig. 1. A chapel in the far north.
Fig. 2. Icebergs at dock area, June 23.
Fig. 3. Dead glacier, Narsarssuah, Greenland.
Fig. 4. Fjord, breaking spring, 1949.

is spectacular. It is at first observed like a spotlight playing on the topmost peaks of the mountains. The band of light day by day moves lower and lower, until finally it has arrived in the valleys, and spring has officially taken over. Nature now throws off the shackles of winter, the ice in the fjords breaks up and moves out to sea; the water falls increase from a trickle to full splendor and activity. The beds of mosses become a shade greener and tiny spring flowers, chiefly in lavender and pink, smile at the dawn of life from prison walls of snow and ice; the arctic char runs up the short rivers, while various

animals, like rabbits and ptarmigans, retreat inland, closer to the borders of the ice.

Summer, the Long Day

Summer comes to Greenland with the 24-hour day. The temperature rises to 70 degrees F. and varies little during the course of the 24 hours. The water of the glacier-fed rivers deepens but warms only a trifle above freezing. The birches and willows are decked in full foliage, but even now cannot hide entirely the rocks and the barren landscape. Rain on Greenland is not heralded by thunder and lightning but it is a gentle shower in a fog-shrouded landscape. Here, as in all parts of the world where life is possible at all, mosquitoes, flies, gnats, and larger horseflies find the warm summer temperature ideal for their life activity. It is interesting to note that the mosquitoes spend the larval stage of their life attached to the underside of rocks in the cold mountain streams. In the spring they emerge, dry their wings in the warm sun, and then fly away in search of warm-blooded organisms, like man, to obtain a square meal.

In the fjords protruding tongues of ice respond to the summer temperature by discarding huge chunks of ice which are then moved to the sea as icebergs by wind and tide. In their journey the huge masses of ice crackle in tiny explosions as the radiant energy of the sun is absorbed by the ice.

Greenland is Greenland, a great arctic land, even in summer. It does not lavish waving fields of grain and abundant agricultural crops upon the sons of man who dare to build their homes on its rocky rim. However, the landscape is not devoid of summer flowers in cheerful colors. The shiny white of the "arctic cotton" merges with the brilliant fuchsia of the "fire bush flower," and the delicate lavender of the fragile hare bell. There is an abundance of sedums nestling among the moss or in rock crevices. There are different kinds, the yellow "salt-and-pepper," and another one which is similar to the common "hens-and-chickens" which we had seen many times in our home state of Ohio. Most flowers of Greenland seem to be miniature, however, the dandelion grows to giant proportions, sometimes reaching a height of 18 inches, with a bloom $2\frac{1}{2}$ inches across.

As the summer progresses we were interested watching the development of the "Arctic cotton." With the approach of autumn the bloom reaches its maximum growth, resembling somewhat the bursting milkweed pods in the states, and like these, are scattered by the autumn breezes.

The advancing portions of ice have finally been sheared off, the fjords become ice-free, and the icebergs have moved out to sea where they frequently become a hazard to ships. The small Island popula-

tion is busy storing food and fuel in preparation for the long winter, and so the summer passes.

Autumn on Greenland

Autumn arrives about September 1. The temperature drops, and the landscape is painted in yellow and brown by the dying leaves of willows and birches, while the carpets of mosses still maintain their hopeful green of the summer. The great ice cap shows the gradually tightening grip of winter's frigid fingers. Icebergs are reduced in

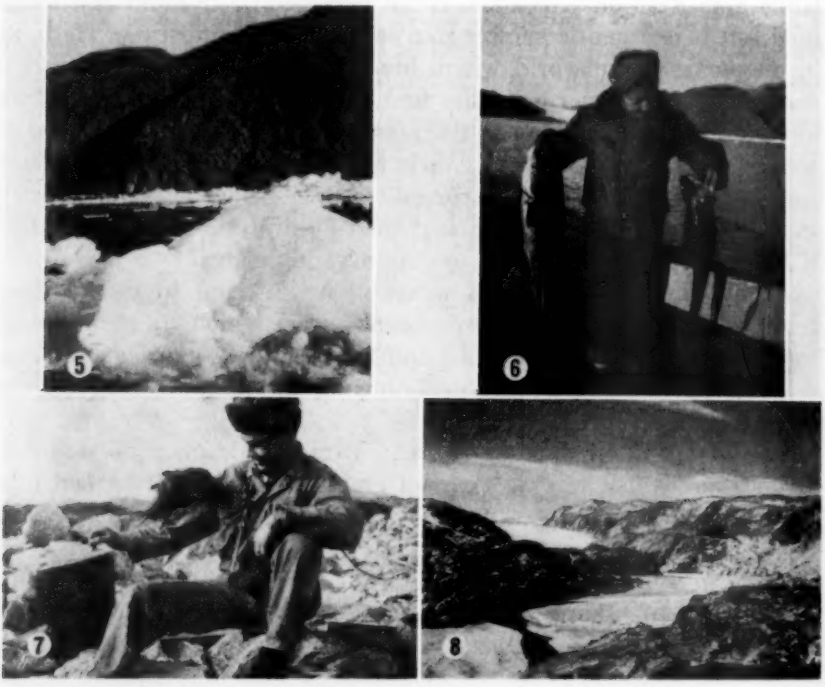

Fig. 5. Icefloes off the coast.
Fig. 6. Dorothy holding some big ones.
Fig. 7. Ravens are tame and bold.
Fig. 8. Gravel flats and river, taken from the air over the hospital area.

numbers as well as in size. Waterfalls become thin ribbons, and rivers shrink in volume of water. The great display of yellow, purple and blue autumn flowers of our central and lakes states are wanting on Greenland, for here autumn flowers are less in evidence than are spring flowers. Shipping declines and at our air base school opens.

School days were the busy season for Dorothy. The school organization provided for instruction in all elementary and high school levels. School was attended by approximately 40 children of Air Force personnel and two little girls from Denmark, Lene and Lotte. Jens,

their older brother, attended the high school classes. Lene and Lotte created some little confusion the first day. The only English they knew was, "Missus Vitney," and Mrs. "Vitney" could not speak a word of Danish. Jens came to the rescue by acting as interpreter until his little sisters had accumulated a wider range of vocabulary. In a very short time they became ardent fans of "Hop-Along-Cassidy," and could "sling" a six-shooter with the best of them.

Organized by Dorothy during our first year in Greenland, the school has developed nicely, using latest methods of instruction. It is now fully accredited and has the distinction of having organized the first PTA near the Arctic Circle. As an example of the teaching approach and the extent of school facilities we can mention that each holiday season the students of all grades participate in an appropriate seasonal program which is broadcast over the local radio facilities. In this way much is accomplished in development of poise and confidence in the children and at the same time provide a medium for their self-expression. Parents and children alike eagerly looked forward to these events. It was fun for all, it was welcomed as an antidote against the depressing loneliness which accompanies isolation.

For two months the sun bows closer and closer to the horizon. In October the white snow mantle of winter is spread over the mountain tops, and slips down the slopes as Old Sol moves southward of the equator. There is an atmosphere of pending restrictions of life activity on this "world in the making." The late fall winds blow in hurricane fury and strain against the universal one-story buildings anchored to the ground with cables. As the days of October click away the blanket of snow has day by day moved silently down the slopes and into the valleys. At last the sun takes one parting look above the rim of the horizon and delegates Greenland to the long winter's night.

The Long, Long Night

Winter's reign begins about November 1. Mountains, hills, and valleys are now covered with snow. Lakes and fjords are bound in ice. Great icicles form on the eaves of the cabins. Ptarmigan, now in snow-white plumage, rabbits, and giant ravens move into the lowlands. The ravens are a daring and noisy group as they gather about the garbage cans at the Base and begrudge one another the morsels of food hidden therein. Shipping has ceased, and outdoor activity of man is at low ebb. Only the most energetic find pastime in skating, hunting, and fishing through the ice. Man-made devices must now be relied upon for indication of passing time, and to assure that in lower latitudes of the world morning and evening still mark the coming and going of a day.

So man huddles about his tiny oases of tolerable temperatures—

the home, and fire places. He dreams of the day when the first flash of sunlight will again light up the topmost mountain peaks and terminate the long nightwatch of pigmy men on Greenland's narrow ice-free rim.

ARCHIMEDES MOVES THE EARTH

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In the study of levers, reference is often made to a statement by Archimedes to the effect that he could *lift* the earth if he had a long enough lever and some place to put the fulcrum. An interesting topic for discussion in the physics classroom concerns the work which must be expended in accomplishing this task.

Now the mass of the earth has been estimated at 6.57×10^{21} tons. Suppose that the mass of Archimedes was 150 lbs., and further, suppose that he had his long weightless lever, his support for the fulcrum, and had enough space cleared in the universe for him to maneuver his lever. Also, to simplify the problem, let us assume a uniform gravitational field action on the earth and on Archimedes, of such strength that the mass and weight are numerically equal. Then the class can show at once that Archimedes could *balance* the earth with a lever in which the longer arm is 8.76×10^{22} times as long as the shorter arm.

Let us now suppose that Archimedes wished to *move* the earth *one ten thousandth* of an *inch* using this lever. The class will now discover that Archimedes would have had to move his end of the lever 1.38×10^{14} miles. Since a light year is about 5.87×10^{12} miles, this means that Archimedes would have had to travel some 23.5 *light years* to move the earth that *one ten thousandth* of an *inch*.

As a furthur bit of fantasy, let us suppose that Archimedes had started in his lifetime (287–212 B.C.) and had devised some means of staying alive and pushing his end of the lever at the enormous speed of a *hundred million miles a day*. The pupils can easily calculate that Archimedes would still have to keep pushing that lever for *more* than another *thousand years* to move the earth that tiny fraction of an inch.

Thus the mental picture that most pupils have of the earth bobbing up and down at one end of the lever, with Archimedes at the other end, is quite inaccurate. The point of the discussion is that while a lever can be used to multiply *force*, it does not diminish the *work* to be done.

METHODS FOR SYSTEMATICALLY SEEKING FACTORS OF NUMBERS

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It is frequently said that number theory is one of the very few areas in the field of mathematics in which the amateur can work with hope of doing more than merely retracing the path that professionals have marked out. This paper is in the nature of an invitation by one number theory amateur to others to tread again one of the delightful old paths.

There are two general problems that relate to the factoring of numbers. The first is, is the number factorable, or is it prime? The second is, what are its factors? This paper is concerned with the second of these questions. No way has ever been discovered for telling at a glance whether a number chosen at random, such as 11,111,111,-111,111,111,111,111, can be factored. And even when, as often happens, one can show that such a number has factors, he is often a long way from being able to tell what the factors are.

One who is interested in trying to find factors of numbers must first concern himself with finding a method or methods by which such factors can be found. Many such methods are known. (See, for example, *History of the Theory of Numbers*, by L. E. Dickson.) Some of these methods are suitable for seeking factors in the neighborhood of $\sqrt{N}$ but are not suitable for seeking factors that are much smaller or much larger because of the magnitude of the computations involved. It is the purpose of this paper to point out some related methods of factoring and to suggest variations that seem suitable for seeking factors not in the neighborhood of $\sqrt{N}$.

A number N can be expressed in the form

$$N=dq+r. \tag{1}$$

Let d be decreased by n, and let q be increased by cn. N will be increased by a value h and we shall have

$$N+h=(d-n)(q+cn)+r.$$

Hence,

$$h=-cn^2+n(dc-q).$$

Then

$$N=r+cn^2-n(dc-q)+(d-n)(q+cn). \tag{2}$$

(2) can be used in seeking factors of N. In factoring N it is con-

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venient to find $[\sqrt{N}]$ as an upper limit of the factors sought, where $[\sqrt{N}]$ is defined to be the largest integer not larger than $\sqrt{N}$. If we let $d=[\sqrt{N}]$, then $q=d$, or $q=d+1$. In (2) if $c=1$, and $q=d$, we have

$$N=r+n^2+(d-n)(d+n). \tag{3}$$

If $q=d+1$, we have

$$N=r+n^2+n+(d-n)(d+1+n). \tag{4}$$

n^2 is the sum of n terms of the progression 1, 3, 5, $\cdots$, and n^2+n is the sum of n terms of the progression 2, 4, 6, $\cdots$. Hence we can express N in terms of r, d, q, and n, n being the number of terms in an arithmetic progression.

It is evident that $(d-n)$, or $(d+n)$, or $(d+1+n)$ is a factor of N if it is a factor of $r+cn^2-n(dc-q)$, whatever the values of the numbers in this expression may be. It is often possible to select or determine these in such a way as to reduce the work of computing factors. The relation to be satisfied is

$$r+cn^2-n(dc-q)=k(d-n), \text{ etc.} \tag{5}$$

In this equation, k, r, n, d, and q are integers; k can be positive, zero, or negative. c can be an integer or a fraction.

(5) can be written in the form

$$n=\sqrt{kd-r+\left(\frac{q-d+k}{2}\right)^2}-\frac{q-d+k}{2}. \tag{6}$$

Example 1. Factor $N=391$. Let $d=[\sqrt{N}]=19$, $q=20$, $c=1$. Then $r=11$. (6) becomes

$$n=\sqrt{19k-11+\left(\frac{1+k}{2}\right)^2}-\frac{1+k}{2}.$$

If $k=1$, $n=2$, and $19-2=17$ is a factor of N.

If we let $c=0$, (5) becomes

$$11+20n=k(19-n).$$

If $k=3$, $n=2$, and again 17 is a factor of N.

In general if $c=0$, and if $d=[\sqrt{N}]$,

$$n=\frac{kd-r}{k+q}. \tag{7}$$

While no square root is involved in this relation, it is obviously not essentially easier to use than the form resulting from giving c a value other than 0.

Example 2. Factor $N=17{,}063$. Let

$$d=[\sqrt{N}]=130, \quad q=131, \quad r=33. \quad n=\frac{130k+33}{k+131}.$$

It is evident that k must be even, so we need not try odd values. Try $k=0, 2, 4, \cdots$. If $k=20$, $n=17$. Hence, $130-17=113$ is a factor of N.

Referring again to (2) we observe that $(d-n)$ is a factor of N specifically if $r+cn^2-n(dc-q)=0$, that is, if $k=0$. This condition cannot be met if c is less than or equal to 1. However, for some value of c sufficiently large this function is negative for some values of n, and hence it passes through zeros. These zeros may correspond to fractional n's and so be of no value in finding factors of N.

Example 3. Factor $N=119$. $[\sqrt{N}]=10$. Let $d=10$, $q=11$, $r=9$, $c=2$. We seek integers to satisfy the relation

$$9+2n^2-9n=k(10-n).$$

If $n=3$, $9+2n^2-9n=0$, and hence $10-3=7$ is a factor of N.

Neither for the methods so far presented is well adapted to the search for comparatively small factors of N. In making this search we may use (1) and let $q=d$. This gives

$$N=r+d^2. \tag{8}$$

Now, let d be increased by n. We have

$$N=r-n^2-2dn+(d+n)^2. \tag{9}$$

We see that $(d+n)$ is a factor of N if it is a factor of $r-n^2-2dn$. Hence, we can seek integers for

$$r-n^2-2dn=k(d+n) \tag{10}$$

or,

$$k=\frac{r-2dn-n^2}{d+n}.$$

Example 4. Factor $N=33{,}559$. By direct division we eliminate primes from 13 to 23 as possible factors. (Simpler methods enable us to tell whether 2, 3, 5, 7, 11 are factors.) Let

$$d=29, \quad r=32{,}718. \quad k=\frac{32{,}718-58n-n^2}{29+n}.$$

If $n=0$, k is not an integer, and so 29 is not a factor of N. The next prime after 29 is 31, for which $n=2$. This does not give an integer for k. The next prime is 37, for which $n=8$. k is an integer and this indi-

cates that 37 is a factor of N.

FERMAT'S METHOD. (10) can be written in the form

$$n=\sqrt{N+s^2}-d-s \tag{11}$$

or,

$$F=\sqrt{N+s^2}-s \tag{12}$$

where $s=2k$, and F is a factor of N. We thus have to seek integers for s such that the number under the radical sign is a square. This is essentially Fermat's method.

Example 5. Factor $N=9{,}296{,}257$.

$$F=\sqrt{9{,}296{,}257+s^2}-s.$$

We try $s=1, 2, 3, \cdots$. $9{,}296{,}257+12^2=3049^2$. Hence $s=12$, and $F=3049-12=3037$ is a factor of N. $3049+12=3061$ also is a factor.

Let d and md be factors of $(N-S)$. That is,

$$\begin{aligned} N-S&=md^2\\ &=mn^2+m(d+n)(d-n)\\ N&=mn^2+S+m(d+n)(d-n). \end{aligned} \tag{13}$$

$(d+n)$ or $(d-n)$ is a factor of N if it is a factor of mn^2+S; and, if n is relatively small, the pair of factors of N, that is, $(d\pm n)$ and $N/(d\pm n)$, will have the approximate ratio $m:1$. Therefore we can use (13) to seek factors having the assumed ratio m to 1. We seek integers for

$$mn^2+S=k(d\pm n)$$

or,

$$n=\frac{1}{2m}\left(\sqrt{4mkd-4mS+k^2}\pm k\right). \tag{14}$$

Since $(N-S)/m=d^2$, it is convenient to take $d=[\sqrt{N/m}]$; $S=N-md^2$. The value of m can be assumed and can be changed as many times as desired in seeking factors of N. In seeking factors near $\sqrt{N}$, $m=1$. For factors near $\frac{1}{2}\sqrt{N}$, $m=4$, and so on.

The magnitude of the labor in computing factors of N is proportional to the error of the assumed value of m as well as to the size of N.

It can be shown that, with n defined as in (2), $n=[\sqrt{N}]-[\sqrt{N/m}]$ gives a relation for factors $N/(d-n)$ and $(d-n)$ in the ratio of m, m being equal to or greater than 1 and not necessarily integral.

VAES' METHOD. While Vaes did not suggest the above general

method, he used a method which can be made corollary to the above by taking $S=1$ and $m=2$. Vaes examines values of $n=1, 2, 3, \cdots$ until he finds $2(r+n^2)+1=k(d+n)$. $r=[\sqrt{(N-1)/2}]$.

Example 6. Factor $N=80{,}047$. If $S=1$, and $m=2$, $d=200$, and $r=23$.

$$\frac{N-1}{2}=23+(200)(200)$$

$$=23+1+(201)(199)$$

$$=23+81+(209)(191)$$

If $n=9$, $23+81=104$. $2(23+81)+1=209$. Hence, 209 is a factor of N.

If we use the more general formula above we have

$$n=\frac{1}{4}\,(\sqrt{1600k-376+k^2}\pm k).$$

If $k=1$, $n=9$, and $200+9$ is a factor of N.

Example 7. Factor $N=10{,}440{,}121$ if it is known that a pair of factors have the approximate ratio 4:1.

Take

$$d=\left[\sqrt{\frac{N}{4}}\right]=1615.\quad S=7221.\quad n=\frac{1}{8}\,[\sqrt{25{,}840k-115{,}536+k^2}\pm k].$$

Obviously k cannot be less than 5. If $k=5$, $n=14$. $1615-14=1601$ is a factor of N.

Example 8. Factor $N=100{,}895{,}598{,}169$ if it is known that a pair of factors have the approximate ratio 8:1.

Take

$$d=\left[\sqrt{\frac{N}{8}}\right]=112{,}302.\quad S=103{,}697.$$

$$n=\frac{1}{16}\,(\sqrt{3{,}593{,}664k-53{,}905{,}184+k^2}\pm k).$$

Obviously k is greater than 14. If $k=15$, $n=1$. $F=112{,}303$.

A slightly different development gives a factor $(d\pm n)$ where

$$n=1/2m(\sqrt{4mN+k^2}\neq(2md+k)). \qquad (14')$$

k may be negative.

Another method for seeking factors of N is not directly related to those given above. It is based upon the observation that factors of N can sometimes be found by using factors of $N-V$ or $N+V$.

Try to find K and M such that

$$KM = N + V, \quad \text{and}$$

$$K + V \text{ is a factor of } N.$$

Development. $N = KM - V = KM + VM - VM - V = M(K+V) - V(M+1)$. Since $(K+V)$ is presumed to be a factor of N, then $V(M+1)$ must be a multiple of $(K+V)$, say $m(K+V)$. Then, $N = M(K+V) - m(K+V) = (K+V)(M-m)$.

Again, try to find K and M such that

$$KM = N - V, \quad \text{and}$$

$$K + V \text{ is a factor of } N.$$

$N = KM + V = KM + VM - VM + V = M(K+V) - V(M-1)$. Assuming that $(K+V)$ is a factor of N, $V(M-1)$ must be a multiple of $(K+V)$, say $m(K+V)$. Then, as above, $N = (K+V)(M-m)$.

Example 9. Factor $N = 52$. Take $V = +3$. $N + V = 55 = 5 \cdot 11 = KM$. $K = 11$, $M = 5$. $52 = (11+3)(5-m)$. From this relation we get $m = 1\frac{2}{7}$, and the method fails to reveal a factor. Again, if we take $K = 5$, and $M = 11$, the method fails. Try $V = 2$. $N + V = 2 \cdot 3^3$. Let $K = 2$, $M = 27$. Then $52 = (2+2)(27-m)$. Hence, $m = 14$, and factors of 52 are $(2+2)$ and $(27-14)$. The reader may verify the fact that $N - V = 49 = 7 \cdot 7$ also reveals the factors.

Biddle's Method. This method results from taking $KM = N + 1$ in the above development. This method will not always reveal factors of N, even though values of K, M, and V are found to satisfy the stated condition. This remark is equally true of the above extension and Biddle's application of this more general form.

A useful theorem results from the extension of Biddle's method. It is this: If $N + V$ and $N - V$ have a common factor, it is a factor of $2N$. Let $N + V = hk$, and $N - V = jk$. Adding, we have $2N = k(h+j)$.

Example 10. Factor $N = 14{,}351$. $N + 1 = 2^2 \cdot 3 \cdot 13 \cdot 23$. $N - 1 = 2 \cdot 5^2 \cdot 7 \cdot 41$. These quantities have no common factor other than 2, and so we have not found a factor of N. Try $V = 2, 3, 4, 5, \cdots$. If $V = 5989$, we have $N + V = 2^2 \cdot 3^2 \cdot 5 \cdot 113$, and $N - V = 2 \cdot 37 \cdot 113$. Since 113 is a common factor of $N + 5989$ and $N - 5989$, therefore 113 is a factor of 14,351.

Conclusion

Persons interested in factoring numbers have available a variety of methods, and can perhaps develop variations of their own. This paper has presented several methods, and in particular has developed methods that are suitable for seeking factors not in the neighborhood

of $\sqrt{N}$. The reader may find interest and profit in trying out these methods on some numbers. Try these which have factors near $\frac{1}{2}\sqrt{N}$:43,157; 294,577; 808,649. Or these which have factors near $\sqrt{N}$:408,257; 1,112,989; or these, the ratio of the factors being approximately 10 to 1:92,441; 191,959. Or these, the location of the factors not being indicated: 2,029,099; 4,691,387.

COUNCIL FOR NUCLEAR RESEARCH

The establishment of a Council for the study of high energy nuclear particles was assured at a Conference of representatives of twelve European nations in Geneva, February 12–15, under the auspices of UNESCO.

The Conference reached full agreement to set up a Council of Representatives of European States for planning an international laboratory and organizing other forms of cooperation in nuclear research. The Netherlands, Germany and Yugoslavia signed definite commitments. France, Denmark, Italy, Greece, Sweden and Switzerland gave their accord, subject to ratification by their respective parliaments. Norway and Belgium are expected to sign after a brief delay. The representative of Great Britain attended the Conference without authority to sign or commit funds.

The Laboratory and its study groups will be under the control of the Council of Representatives, with its seat in Geneva. The Council will supervise such activities as a special study group at the Institute for Theoretical Nuclear Physics at Copenhagen. It will function independently of UNESCO, with whom it will have a special agreement. The Council will operate on funds granted by the participating states. Guarantees have already been subscribed in the amount of $71,000 by France, $35,000 by Germany, $25,000 by Italy, $23,000 by Switzerland, $20,000 by Belgium, $10,000 by Netherlands, Sweden and Yugoslavia, $8,000 by Denmark, $5,000 by Norway and $4,000 by Greece. The cost of the first year's work of the Council is estimated at $200,000.

The Laboratory and the Institute will provide centers of study beyond the financial capacity of the separate nations. They will offer scientists, and especially, students, the opportunity of participating more fully in the new science of nucleonics. It is expected that the Laboratory will be equipped with a cyclotron of 500 million electron-volts and a powerful cosmotron of 3 to 10 billion electron-volts. The purpose is, of course, one of pure science without military implications. All the results of research will be freely published.

The plans for the Laboratory and of its equipment will be drawn up by Study Groups. There is little expectation that construction can begin within two years.

BOSTON UNIVERSITY SUMMER TOUR

This is an early announcement that one of the Boston University summer travel trips for the summer of 1953 is being planned to meet the interests of secondary school teachers of mathematics and science. This ten-week trip will include visits to schools, meetings with leaders in education, museum exhibits in mathematics and science, and scientific laboratories. Ample time will be allowed for recreation as well. Complete details and itinerary will be available after August 1, 1952, by writing to Professor Henry W. Syer, Boston University School of Education, 332 Bay State Road, Boston 15, Mass.

UNIVERSITY OF WILLIAM LIBRARIES

VITALIZING THE CLASSROOM

MUSEUM EXHIBITS AND DIORAMAS

SAM S. BLANC
East High School, Denver, Colorado

As the teacher finds that objects, specimens, and models increasingly vitalize his instruction in the class, more and more of these concrete instructional materials will be accumulated. How these materials may be classified, organized, and displayed so that their values are available at all times to the pupils soon becomes an important problem. The logical solution is the organization of a school museum. Many progressive schools have found it advisable to organize school museums, give them definite, conveniently accessible housing space, and appoint some member of the faculty as the person with responsibility for these materials. Museum exhibits may be of three types: (1) room museums, (2) building museums, and (3) district museums. The chief emphasis in this article will be on the room museum organized by the individual teacher.

Obviously, there is no limit to the extent to which a room museum may be developed. Were the teacher so inclined, the entire class activity for a year could be devoted to the collection, classification, and display of the materials. Of course, the thoughtful teacher will soon realize that there are many other worthwhile activities in which the class might engage besides working on exhibits. Hence, definite criteria should be kept in mind in making decisions in connection with this type of activity.

The wealth of materials within easy reach of practically every teacher will make the collection of materials for room exhibits a pleasant task. It requires only a little ingenuity to discover the sources of available items. Materials may readily be obtained from sources such as the following: the school area and the surrounding country, homes of the pupils, industrial establishments, commercial business concerns, commercial museums, and exchanges with other school museums.

The display and arrangement of any group of materials in an exhibit should follow some definite theme. For example, the exhibit might be organized with respect to some common function of the objects; it might be arranged to show progressive stages of development; or it might be organized to show certain relationships among the objects on display. Other methods of grouping will come to the mind of a person interested in this type of activity.

An unusual type of exhibit is the diorama. These exhibits originated in the larger museums, and are just beginning to be developed for

classroom use. The diorama may be defined as: "The miniature, three-dimensional group consisting of small modeled and colored figures and specimens, with accessories, in an appropriate setting, and in most instances artificially lighted. The scale and the size of the group is variable; there is no standard shape; there is no limitation as to the subject matter, which may be realistic or imaginative according to what the creator of the group wishes to portray."[1] The diorama probably developed from the habitat groups common in most museums. However, habitat groups are usually made of life-size figures and objects, whereas dioramas are always miniature representations. The miniature figures in the diorama are usually painted and dressed with painstaking detail and are placed in a realistic setting. Properly arranged and lighted, the diorama is capable of producing an unusual sense of reality in the observer.

Because these exhibits may be constructed of relatively inexpensive materials, and because they furnish an outlet for pupils who are interested in handicraft, dioramas seem to offer many possibilities for classroom use. By means of these miniature exhibits it is possible for pupils to set up highly realistic displays of animal groups, plant arboretums, scenes from the past, and representations of life in other parts of the world. Applications in the study of industry, the community, life sciences, social studies, geographic relationships, and other such topics readily suggest themselves to the teacher interested in exploring the use of dioramas.

In summarizing the criteria for the selection and utilization of museum exhibits and dioramas, several principless tand out. Like any other instructional materials, these aids must be integrated into the curriculum. No instructional material should be used in isolation from other teaching procedures. The teacher must select these materials so that they meet a given need of the pupils. Preparation before use with the class is essential. More than the average amount of pupil activity is possible in this partiular type of instruction. In many cases these exhibits and dioramas may be an outgrowth of the utilization of some other type of instructional materials. Much of the value of this class of aids comes through the making and handling of these materials by the pupils, rather than in their preparation by the teacher. So far as possible, these materials should be where the pupils may study and examine them instead of being locked up behind glass in an exhibit case.

Pupils must be taught to observe the exhibits. It follows, then, that active teaching is necessary if the most effective use is to be made of these instructional materials. The pupils must be prepared

[1] Anna C. Chandler and Irene F. Cypher, *Audio-Visual Techniques* (New York: Noble and Noble, Inc., 1948), p. 26.

for what they are to observe, and they should be given guide questions to help them select the important concepts related to the unit under discussion. Follow-up activities are as essential here as for any other type of classroom activity. Exhibits and dioramas are concrete learning experiences. Pupils must be taught how to draw inferences from the minimum facts observed. Relationships of a more abstract nature should be developed with the class so that the pupils will begin to see how the particular museum materials have contributed to their understanding of broader concepts and generalizations.

THE BLUE BOOK

More than a thousand new motion picture titles appear in the latest revision of the BLUE BOOK of 16 mm. FILMS, just off the press, according to an announcement by its publisher, *The Educational Screen*, official journal of the National Education Association's Department of Audio-Visual Instruction. More than 7,000 films are described—with full data given as to whether they are sound or silent, color or black-and-white, length, TV rights, original source and chief national distributors. Nearly four hundred national sources are given, with the films each distributes clearly indicated. In addition there is an extensive geographical directory aid in locating nearby sources of films and equipment. The titles are arranged under 182 separate subject headings ranging from Air Travel to Zoos. An alphabetical Index affords easy and quick location of films by titles.

This is the 27th edition—the first appeared in 1922. Its original title, "1001 Non-Theatrical Films"—was chosen because three decades ago this was all the film titles that could be scraped together, from all possible sources. The present 7,000 current listings are kept up-to-date by the culling of obsolescent materials to make room for the new. The book, 172 pages, in 6×9 size, is designed for handy daily reference use.

The BLUE BOOK is principally used by film librarians, and by program chairmen and educators having responsibility for the selection of films for schools, churches, industry and community organizations.

It is sold through audio-visual, school-supply, photographic, book and other dealers, and by the publisher, The Educational Screen, at 64 E. Lake St., Chicago 1, Ill. A single copy costs $1.50.

DR. GEORGE POLYA HONORED

Dr. George Polya, Stanford professor of mathematics, has just been elected an honorary member of the French Mathematical Society.

This is a distinction held by only six mathematicians outside of France. Only two of the six are Americans, Dr. Marston Morse and Dr. Oswald Veblen, both of the Institute for Advanced Study, Princeton, New Jersey.

Professor Polya was awarded a similar honor in 1947 when he was elected to the French Academy of Sciences, a distinction also held by only two other living Americans.

Dr. Polya has been a member of the Stanford mathematics faculty since 1942. He was born and educated in Hungary and taught in the Swiss Federal Institute of Technology for 29 years before he came to America. He held the position of dean of the Institute when he resigned to visit the United States and teach at Brown University in 1940.

DRAMATIC INCIDENTS IN THE EVOLUTION OF PHYSICS

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Longview, Washington

It is reported[1] that Franklin, when asked about a demonstration, "What's the use of it?" replied, "What's the use of a new-born child?" In a sense, the incidents about to be related, were as new-born children in the world of science when they occurred. They became meaningful in the mind of each scientist as he probed their implications. They were potentials which became kinetic in the hands of their observers.

GRAVITY

William Stukeley was a friend of Sir Isaac Newton even though forty-five years Newton's junior. He tells[2] of one of his visits with Newton, "After dinner . . . we went into the garden and drank tea, under the shade of some apple trees. . . . Amidst other discourse, he told me, he was just in the same situation as when formerly the notion of gravitation came into his mind. It was occasioned by the fall of an apple, as he sat in a contemplative mood. Why should that apple always descend perpendicularly to the ground . . . ? Why should it not go sideways or upwards? . . .

"Assuredly the reason is that the earth draws it. There must be a drawing power in matter. . . . The apple draws earth as well as earth draws the apple. There is a power, . . . that we here call gravity, which extends itself through the universe. . . . This was the birth of those amazing discoverys," Stukeley concludes, "whereby he built philosophy on a solid foundation, to the astonishment of all Europe."

BUOYANCY

Hiero of ancient Syracuse, as well as Stalin of modern Russian, had his troubles. The story[3] runs somewhat as follows, "Hiero, king of Syracuse, had given his jeweler a certain weight of gold to be fashioned into a crown. . . . Hiero suspicioned that his jeweler had stolen part of the gold and had replaced it by silver. He therefore commissioned his court scientist, Archimedes, to detect the fraud.

"After many days of fruitless research, Archimedes was about to abandon the task. But one morning, as he stepped into his tub at the public bathhouse, he noticed the overflow of the water. The sight

[1] Vallery-Radot, Rene. *Life of Pasteur*. Page 76. Doubleday, Page & Co., Garden City, N. Y. (1924).
[2] Andrade, E. N. dac. *Isaac Newton*, Page 30. Chanticleer Press, N. Y. (1950.)
[3] Thomas, Henry & Thomas, Dana Lee. *Living Biographies of Great Scientists*. Pp. 3–4. Garden City Publishing Co., Garden City, N. Y. (1941).

of this set his imagination aflame. Forgetting his naked condition, he leaped out of his bathtub and ran home through the streets crying, 'Eureka!, Eureka!' (I have found it! I have found it!)

"What he'd found was a simple solution of the problem about Heiro's crown." How so? He would secure equal masses of gold and silver with that of the crown. He would measure the overflow as each was submerged in equal volumes of water.

Result: He found that displacement by the crown was more than that by the gold and less than that by the silver. Heiro's suspicions were correct. (We are not told what became of the jeweler.)

This seems to be the first recorded use of the principle of physics, called Archimedes' principle, which is stated, "A body submerged in a fluid is buoyed up by a force equal to the weight of the fluid it displaces."

Nature's Rhythm

Again we turn to Italy.[4] "A young (seventeen year old) medical student at Pisa was kneeling in the Cathedral. There was silence over the vast auditory save for the annoying rattle of a chain. A sacristan had just filled a hanging oil lamp and had carelessly left it swinging in the air. The tick-tack of the swinging chain interrupted the student's prayer and started him upon a train of thought that was far removed from his devotions.

"Suddenly he jumped to his feet, to the amazement of other worshipers. A flash of light had descended upon him in the rhythm of the swinging lamp. It seemed to him that this rhythm was regular and that the pendulum of the rattling chain was taking exactly the same time in each of its oscillations although the distance of these oscillations was constantly becoming less and less. . . . He must rush home and find out . . . if . . . he had (made a) discovery . . . (or) had (merely) suffered an illusion."

His Grandfather, Mugio Telaldi, was asked to help with an experiment using two strings and two nails. Each was "to count the motions of the threads," which had been made equally long from hand to nail and were made to swing through different arcs. After many trials he became convinced that his impression of the regularity of rhythm of the lamp in the Cathedral was no illusion; the times of oscillation of a pendulum is the same and independent of the length of the arc through which it swings. This law of the pendulum, it is said, became the basic starting impetus of a whole new scheme of clock making. While Galileo did not himself make a pendulum clock, he suggested such an instrument fifty years later.

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[4] Thomas, Henry and Thomas, Dana Lee, *loc. cit.* Pp. 35–36.

X-Rays

"Wilhelm Conrad Roentgen[5] was working with an air-evacuated tube through which he discharged electricity. He covered the tube with a heavy shield of black cardboard. A piece of sensitive, chemically treated paper lying near the tube on the bench, upon which he had the tube, presently showed a peculiar black line. He knew such a line could come only by its exposure to strong light. Since there was no other source for this 'strange light' he reasoned that it had to come from the tube even though it was heavily encased by the thick paper. (That was on Nov. 8, 1895.)

"He at once began a series of tests of these mysterious rays and found they not only were transmitted through black paper but through cloth, wood and metals. He even tried his hand and found they went through the flesh but that his finger bones cast shadows on the film. The discovery was in December 1895 and he read a paper describing his discovery to the Berlin Physical Society on January 4, 1896."

Unlike Galileo's wait of fifty years to suggest the use of his discovery, these "X-Rays" were utilized almost from the moment of their discovery both in a practical way and as a stimulus for further productive investigation of other "invisible" rays.

Electrical Identities

Benjamin Franklin was one of the earliest to suggest the idea of the "sameness of lightning with electricity." The story[6] of his kite experiment is told by Joseph Priestley. "The Doctor, . . . was waiting for the erection of a spire (on Christ Church) in Philadelphia to carry his . . . (experimental test of the sameness of lightning and electricity) . . . when it occurred to him that by means of a common kite he should have better access to the regions of thunder than by any spire whatever. Preparing . . . a large silk handkerchief (kite) . . . he took . . . (it into) . . . the first approaching thunder storm. . . . Dreading the ridicule which too commonly attends unsuccessful attempts in science, he . . . (told) his intended experiment to nobody but his son (then twenty-one years old) who assisted him in raising the kite.

". . . Considerable time elapsed (after the kite was raised) before there was any appearance of its being electrified. One very promising cloud had passed over it without any effect; when, at length, just as he was beginning to despair . . . , he observed some loose threads of the hempen string to stand erect, and to avoid one another. . . .

[5] Lansing, Marion Florence. *Great Moments in Science*. Pp. 181–85. *Doubleday, Page Co.* Garden City, N. Y. (1926).

[6] Van Doren, Carl. *Benjamin Franklin*. Pp. 164–65. The Viking Press, N. Y. (1938).

Struck with this promising appearance, he immediately presented his knuckle to the key, and the discovery was complete. He perceived a very evident electric spark. Others succeeded, even before the string was wet, so as to put the matter past all dispute, and when the rain had wet the string he collected electric fire very copiously. This happened in June 1752, a month after the electricians in France had verified the same theory, but before he heard of anything they had done."

Franklin's own account of the application of the assumption that lightning is the same as electricity runs as follows: "It has pleased God in His goodness to mankind, at length to discover to them the means of securing their habitations and other buildings from mischief by thunder and lightning. The method is this: . . . " (He then describes the construction and erection of lightning rods.)

Magno-Electricity

It was one thing to attract electricity from the clouds but something else to generate it on earth's surface. Franklin and contemporaries did their experiments largely by aid of friction-type generators. Later it was found that chemical change could be relied upon to get "steady flow" electricity. "Oersted,[7] in 1820, had shown that an electric current through a wire changed the direction of a compass needle.

"If a current through a wire could make a magnetic needle move; query, could a moving magnet make a current move in a wire? Faraday worked for seven years on that idea.

"One day in 1831 he thrust a barmagnet into a hollow coil of wire and got a 'kick over' of his galvanometer needle. He tried it several times and was presently exclaiming, 'There it goes! There it goes!' and was dancing around the laboratory table and rubbing his hands in glee. So excited was he at the discovery that he took the rest of the day off for a holiday, going to Astley's circus to see the performing horses."

Faraday made this discovery in 1831. One year later, 1832, he made a little machine for generating electricity by "magnetic-influence" which he called a dynamo. This dynamo-machine in time became the means by which water power was transformed into electricity and so a sort of key to the modern age of electricity.

The story is told that the statemean, Gladstone, was present at one of the public meetings at the laboratories of the British Royal Society. Faraday had demonstrated the operation of the magnet-wire-coil experiment.

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[7] Lansing, Marion Florence, *loc cit.* Page 203.

Gladstone asked, "What's it good for?"

To this Faraday is reported to have replied, "It may be good to tax some day."

Thus we have passed in review a half dozen incidents which are reputed to have happened to individuals who were alert enough to lift them to a place of significance in the story of the science of physics. There are many others of equal interest and worth for the searcher for the dramatic as well as for the prosaic truths of the subject. Such occasional digressions may serve as an appetizer for the usual prescribed menus of our class rooms.

ON THE MEANING, USE, AND IMPORTANCE OF ZERO

A. N. TUCKER

J. Sterling Morton High School & Junior College, Cicero, Illinois

To the cipher, 0, has been given the name "goose egg," egg because of the general shape and goose because inaccurate observers have attributed to that fowl a minimum of sense. This latter is an outgrowth of the prevalent and erroneous notion that 0 stands for *nothing*. The subtleties of the distinction are not too great for an active mind.

Suppose a person plays a game of shuffle-board. His puck might fall on $+8$, $+7$, -10, $+8$, -10, $+7$ and -10 successively. His final score is zero, yet he has shot as many strokes, taken as many steps, gained as much exercise as his opponent who wins the game with $+32$. This is in no wise the same as sitting on the side lines watching the performance yet doing nothing.

Or let a person play a competitive game in which he wins no points. His score is 0. This states his final position; yet the child view is that since he has nothing, his score is nothing, or synonymously, zero. The inventor of tennis knew the fallacy and met the issue by calling the pointless score *love*. And certes; there is none so inexperienced as to claim that love and nothing are one and the same.

But to the youth who has followed Newton into the realm of an infinitesmal, the idea of zero as a static spot on a number scale is simplicity itself. That two variables may independently approach zero but that their ratio may approach some finite quantity, or that such variables, approaching zero, may be added and their sum be represented by a number calls for imagination and penetration of high order. Very different is it from that required of the lad who multiplies 4 times 125 by automatically putting down 0 and carrying

two,—though chances are, neither boy really knows what he is up to.

The place value of zero (which makes 5 into 500) is of primary importance. And lest you forget it, and lest you ever be tempted to confuse 0 with *nothing*, the twofold lesson should be driven home.

A bank account provides the means. Let us suppose your present balance—in the interest of increasing your respect for and comprehension of that oval symbol—stands at a couple of 0's preceded by a period preceded by three more 0's preceded by a comma preceded by a 1. Now you will note that there is not a high powered figure in the lot; just a string of zeros and the lowliest of all digits, 1. Yet the bank will pay you more simoleons for that number than they would for any three place number you care to make, even using all your fancy nines!

Those goose eggs in that $1,000.00 must have belonged to the bird that laid the golden eggs.

At J. Sterling Morton High School during 1944, this and other essays were given to a high section beginning algebra class. Four years later, some of the students began their college work in algebra and continued through the calculus at Morton Junior College.

It was interesting to note than when $\frac{5}{0}$ occurred, as it does, for example, in solving linear equations by determinants, the students did not fall into the all too common error of argument that the answer is 5 "because you don't divide by anything." Of course, the fact that they had the same teacher in college as in first year high school might have had something to do with the awareness.

An indirect effect of ideas presented a little out of textbook treatment and of the suggestion of things to come on a higher level is to direct some students toward further study of mathematics.

A FULBRIGHT AWARD TO EARL R. GLENN

Prof. Earl R. Glenn of Upper Montclair, head of the science department at Montclair State Teachers College, has been selected the recipient of a Fulbright Award, according to word received this week from the U. S. Department of State. As one of approximately 340 educators receiving grants for lecturing abroad under the Fulbright Act, he will serve as a visiting lecturer in educational psychology at Central Philippine College, Iloilo City, The Philippines, from July 1.

A graduate in physics from Indiana University, class of 1913, Professor Glenn later studied at the University of Chicago and received his master's degree in science education from Teachers College, Columbia University, in 1928. In 1917, he was appointed a member of the initial faculty at The Lincoln School, Teachers College. He has served as head of the M.S.T.C. science department since 1928, the year the State Department of Education established the four-year curriculum in secondary education.

Listed in *Who's Who, American Men of Science* and *Leaders in Education*, Professor Glenn is a Fellow of the American Association for the Advancement of Science and a life member of the National Education Association. He is founder of the National Science Teachers Association and the National Association for Research in Science Teaching.

A NEW METHOD FOR DETERMINATION OF WATER HARDNESS

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The customary method for determination of water hardness is to titrate a definite volume of the water with a standard soap solution, the strength of the latter being indicated in terms of calcium carbonate.[1,2] This method is open to several objections: 1. The end point, production of a permanent lather, is difficult to reproduce. 2. A lather factor must be determined. 3. Standard soap solution is somewhat difficult to prepare. 4. The titration is slower than most titrations. 5. The soap titration is totally unreliable when the hardness of water is low such as is the case in zeolite softened water. Difficulty in objection 1 leads to poor precision and to inaccuracy due to the difference in judgment of the proper amount of lather for the end point. A trained worker can achieve good results, but it takes considerable practice to acquire the ability to obtain satisfactory data. In the case of objection No. 2, a certain amount of soap solution is required to produce a lather in perfectly soft water. This necessitates the subtraction of this volume from the total volume used in the hardness titration, thus complicating the required calculations. The determination of the lather factor again is open to the same errors as is the end point in the hardness titration.

Recently a method has been developed[3,4,5] which makes possible the titration of hard water with a reagent called versenate. A special indicator, Erichrome Black T, is used to indicate the equivalence point. The procedure is similar to and as simple as an acid base titration. A small amount of buffer solution must be present as the reaction must take place at a pH of around 10.

Versenate is typical of a number of substances which are capable of sequestering calcium, magnesium, and other metal ions. Sequestration consists in tying up these ions in stable complexes which prevent the ions from reacting with and precipitating soap. Sodium hexametaphosphate, $(NaPO_3)_6$, sodium tripolyphosphate, $Na_5P_3O_{10}$, and tetra sodium pyrophosphate, $Na_4P_2O_7$, all possess this property. A versenate is a salt of ethylenediamine-tetraacetic acid abbreviated H_4

[1] *Standard Methods for the Examination of Water and Sewage*, 9th Edition, American Public Health Association, New York, N. Y.

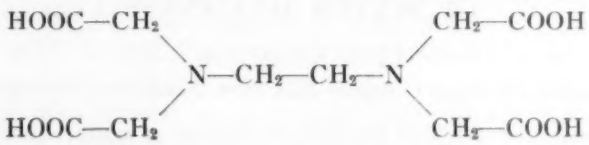
[2] Snell and Biffen, *Commercial Methods of Analysis*, McGraw-Hill Book Company, New York. 1944. P. 234.

[3] Diehl, Goetz, Hach, "Versenate Titration for Total Hardness," *Journal American Water Works Association*, 42, Pp. 40–48. January 1950.

[4] Hach, Clifford, Mimeographed Material, Hach Chemical Company, Ames, Iowa.

[5] Rossum & Vallarrus, "Rapid Methods for Total Hardness," *Water and Sewage Works*, 96, Pp. 391–392. (1949.)

Ver. The particular one used for the water titration is disodium dihydrogen versenate, Na_2H_2 Ver. Versenate, although expensive,



about $1.00 per pound, is used as a most effective water softener, frequently being incorporated in special soaps. The sequestering agents named are particularly effective water softeners as they do not precipitate hardness as other water softeners do, and they remove practically all traces of hardness.

The chemistry involved in the versenate hardness titration is as follows. The versenate combines first with the calcium, then with the magnesium in the water, and finally with the indicator which has formed a wine red compound with the magnesium. This latter reaction results in a sharp color change from wine red to blue, the equivalence point. The addition of the buffer to produce a pH of 10 is necessary because above this pH magnesium hydroxide may be precipitated and at lower values the magnesium is not strongly enough bound in the indicator.

Reagents

1. Buffer solution. Mix 67.5 g of ammonium chloride and 570 ml of concentrated ammonium hydroxide and dilute to 1 liter.

2. Indicator solution. 0.5 g Erichrome Black T dissolved in 100 ml of ethyl or isopropyl alcohol.

3. Standard calcium chloride solution. Dissolve 1.000 g of pure calcium carbonate in a little hydrochloric acid. Dilute to exactly one liter. 1 ml of this solution is equivalent to 1 mg of calcium carbonate.

4. Standard sodium versenate solution. Dissolve 4 g of disodium dihydrogen versenate and 0.1 g of magnesium chloride or magnesium sulfate in water and dilute to a liter. If it is desired to produce a solution of such a concentration that 1 ml is equivalent to 1 mg of calcium carbonate dissolve the versenate in about 800 ml of water, standardize and dilute the solution to the desired strength.

Reagents can be obtained from Distillation Products, Rochester 3, New York. Disodium Versenate (cat. no. 6354) costs $3.25 per 100 g; Erichrome Black T (cat. no. P6361) costs $1.65 per 100 g. These reagents are also supplied by the Hach Chemical Company, Box 597, Ames, Iowa. This company also supplies the reagents in

solution made up to the proper strength. Pure calcium carbonate can be purchased from any scientific supply house which handles chemicals.

Standardization of Versenate

Use one or two ml of buffer solution and 4 or 5 drops of indicator for each titration. Titrate the versenate against at least 20 ml of the standard calcium chloride solution. The strength of the versenate is determined by dividing the number of ml of calcium chloride by the number of ml of versenate used in the titration. The result will be expressed as mg of calcium carbonate per ml of versenate.

Procedure for Hardness of Water

The general procedure outlined for standardization of the versenate solution can be used. Use a 50 ml sample of water instead of the standard calcium chloride solution and to this add 1 or 2 ml of buffer solution and 4 or 5 drops of indicator. To determine the hardness of the water the following formula may be used.

$$\text{Hardness in parts per million} = \frac{\text{ml of versenate solution} \times \text{mg of } CaCO_3 \text{ per ml of versenate} \times 1{,}000{,}000}{\text{volume of water in ml}}.$$

The size of the water sample may be varied depending on the hardness of the water. Water ranging from 2 to 1200 ppm may be successfully titrated. The factor 0.0584 may be used if it is desired to convert the hardness in ppm to grains per gallon.

Several metal ions cause interference,[3] but the one most apt to be present is iron which causes the end point to be indistinct. This effect can be prevented if the buffer is added before the indicator which causes the iron to precipitate as the hydroxide.

If versenate is used to determine the hardness remaining after softening agents such as trisodium phosphate, sodium carbonate, etc. have been added, the precipitate produced should be filtered off and the pH adjusted to 10. The versenate will react with the precipitated hardness. Addition of a little ammonium chloride should be sufficient to adjust the pH. The hardness of water softened by the phosphate sequestering agents previously mentioned can not be determined by versenate as it decomposes the phosphate complexes.

The author has used the versenate method in general chemistry classes to determine hardness of water and the extent of softening

produced by various methods. Satisfactory results were readily obtained by the students.

The versenate method can also be adapted to the separate determination of calcium and magnesium in hard water.[3] This is accomplished by precipitating the calcium as the oxalate and filtering. The magnesium in the filtrate is titrated with versenate. The calcium is then determined by subtracting the magnesium from the sum of calcium plus magnesium as determined by a second versenate titration.

SAFETY ON THE STREET

Every morning and afternoon thousands of boys and girls in this country walk to and from school unaware of the dangers involved in crossing busy streets or playing along the roadside.

In an effort to teach children proper safety measures, Encyclopaedia Brittanica Films has released a new educational film, SAFETY ON THE STREET, designed to encourage habits of safety on the way to and from school. The new film is available in either full-color or black and white and has a running time of 11 minutes.

It is the belief of EB Films that while some of the responsibility of safety rests with the adult community; the motorists, the law officers, the parents, and the school officials, children must also learn to accept their share of the responsibility for street safety, for the core of the safety problem lies with the child himself, Walter Colmes, EB Films president, said. SAFETY ON THE STREET is designed to help children visualize traffic situations and their own behavior in relation to the hazards of the streets. This film is planned for middle grades and is adapted to the broad purposes of the safety education program for use in such areas as health and hygiene, safety education, language arts, and physical education.

SAFETY ON THE STREET may be purchased for $100 (full-color) or $50 (black and white) from Encyclopaedia Brittanica Films, Wilmette, Illinois, or from any of the nine EBF preview and rental libraries in New York; Boston; Chicago; Atlanta; Birmingham, Michigan; Dallas; Portland, Oregon; Hollywood, and Willoughby, Ohio.

FIRST PROGRESS REPORT

The 81st Congress directed U. S. Commissioner of Education Earl James McGrath to conduct a survey of public elementary and secondary school facilities in the 48 States, the District of Columbia, Alaska, Hawaii, Puerto Rico, and the Virgin Islands. (All defined in this report as "States.") This survey, the first of its kind ever attempted, is being conducted under the immediate supervision of the several participating State educational agencies in cooperation with the Office of Education.

The survey consists of two phases: the first—an inventory of existing school facilities, current needs for additional facilities, and State and local resources currently available for meeting these needs, the second—the development, State-by-State, of long-range master plans for programs of school plant construction.

The *First Progress Report* includes only the inventory of existing school facilities in the 25 States that have now completed this portion of the first phase of the survey.

FIRST PROGRESS REPORT OF THE SCHOOL FACILITIES SURVEY 1951–1952. *Authorized by Title I, Public Law 815, 81st Congress.* Prepared by the School Housing Section of the Office of Education. 77 pages. 1952. For sale by the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. 40 cents.

HOW MATHEMATICALLY LITERATE IS THE TYPICAL NINTH GRADER AFTER HAVING COMPLETED EITHER GENERAL MATHEMATICS OR ALGEBRA?

MILTON W. BECKMANN
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If the world in which mathematics is used would remain static; if there were no problems in the teaching of mathematics; if all children had been created "equal" mentally, morally, emotionally, and socially; if all teachers followed in the footsteps of the Master Teacher, possessing in degrees such characteristics as He possessed: patience, kindness, humility, and willingness to serve; if all the necessary applications of mathematics were known; if application of the best methods were used, then the objective of advancing the teaching of mathematics would be superfluous.

But such a Utopia has not been reached. Until then teachers of mathematics will continue to experiment and to discuss their problems in groups. It will also continue, therefore, to be necessary to make known their findings and recommendations to other teachers. The very important report, *The Reorganization of Mathematics in Secondary Education*, often called the 1923 Report, under the auspices of The Mathematical Association of America, was a primary force in the betterment of the teaching of mathematics. It listed in considerable detail the specific mathematical objectives necessary for citizenship. It gave impetus to the movement for reform.

Since 1923, the world has seen tremendous changes. The most startling discoveries have come in the last quarter of a century: electronic eyes and ears; unprecedented mobility of machines; the critical discovery of the controlled fission of uranium; radioactive tracers and many other scientific achievements have been accomplished. The secondary school doubled its enrollment each decade from 1880 to 1930; the disciplinary, practical, and cultural aims of mathematics do not continue to influence practice and content as much as formerly; there are changing social and economic conditions affecting secondary education; there are new psychological theories affecting secondary education, and a loss of confidence in the educational values of mathematics. It is evident that such changes in world and educational conditions called for a reconsideration of the aims and content of mathematical instruction.

It is quite a coincidence indeed that in any one year there would appear in the same subject field two deliberative reports of national committees as challenging as *The Place of Mathematics in Secondary*

Education,[1] and *Mathematics in General Education*.[2] Does mathematics belong in general education in the secondary school? This is the primary question to which the two reports are directed. They are directed to substantially the same audience, primarily teachers who are teaching mathematics in secondary schools, but also curriculum specialists, school superintendents and high school principals.

Soon after the above mentioned reports were published, there followed the exceedingly important reports called The First and Second Reports of the Commission on Post-War Plans. These reports presented suggestions for improving mathematical instruction from the beginning of the elementary school through the last year of junior college. The Second Report[3] goes distinctly beyond earlier reports in the matter of clarifying the aims for mathematical instruction. The most important thesis of the Commission's various reports was *mathematical literacy for all who can possibly achieve it*. The essentials for functional competence in mathematics were put as 29 questions in a Check List.[4] The Post-War Commission felt that if a person could say "yes" to the 29 questions (competencies) in the Check List he might be considered mathematically literate.

Statement of the Problem

The writer conducted a study[5] to measure the level of mathematical competency attained, using the 29 competencies promulgated by the Commission on Post-War Plans, as a basis for the development of an evaluating instrument. The relative gains in such competencies as a result of the study of algebra and general mathematics in the ninth grade in Nebraska High Schools was the main problem investigated.

Organization and Design of the Study

To make the necessary comparisons, it was necessary to find schools that required all ninth grade pupils to take algebra, and schools that required all ninth grade pupils to take general mathematics. There were approximately one hundred schools in Nebraska

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[1] Joint Commission of the Mathematical Association of America, Inc., and the National Council of Teachers of Mathematics, *The Place of Mathematics in Secondary Education*, Fifteenth Yearbook of the National Council of Teachers of Mathematics (New York: Bureau of Publications, Teachers College, Columbia University, 1940. Hereafter referred to as the Joint Commission Report.)

[2] Commission on Secondary School Curriculum of the Progressive Education Association, *Mathematics in General Education* (New York: D. Appleton-Century Company, Inc., 1940). (Hereafter may be referred to as the Commission of the P.E.A.)

[3] Raleigh Schorling (Chairman), "The Second Report of the Commission on Post-War Plans," *The Mathematics Teacher*, 38: 197–198 (May, 1945).

[4] *Ibid.*

[5] Beckmann, Milton Wm. "The Level of Mathematical Competencies and Relative Gains in Competency of Pupils Enrolled in Algebra and General Mathematics" (Unpublished Ph.D. dissertation, Department of Secondary Education, University of Nebraska, 1951).

which met one or the other of these requirements. Of course, a number of high schools in Nebraska offer both algebra and general mathematics in the ninth grade. These schools could not be included since the assumption of homogeneity in the two types of classes would probably have been unwarranted. Out of the one hundred schools listed, fifty-one were selected for inclusion in this study. In choosing the fifty-one schools, consideration was given to geographical location so that all areas of Nebraska are represented.

Early in September, 1950, letters were written to the superintendents of the 51 schools requesting their participation in the study. Three schools had changed their course offering, consequently, they could not be included. Only one declined to participate in the study. Thus 47 schools were originally included in the study. Not all of the schools which agreed to participate were able to complete the study. Forty-two Nebraska High Schools, with 1,296 students enrolled in algebra or general mathematics, were selected for final inclusion in this study. Twenty-five of these schools, with 734 pupils participating, required all ninth graders to take general mathematics. Seventeen schools, with 562 pupils participating, required all ninth graders to take algebra.

Construction of a Test and Experimental Procedure

Since the study was to measure the level of mathematical competency as defined by the 29 competencies, and relative gains made by students in such competencies, as a result of the study of algebra and general mathematics, it was necessary to obtain a test which would measure functional competence in mathematics in terms of the 29 competencies found in the Check List. Since no satisfactory instrument could be found, it was decided that one should be constructed. A detailed explanation of the construction of the Mathematical Literacy Test is given in Chapter V of a study conducted by the writer.[6] The test was divided into two parts with 55 items in each part. The steps taken in this study follow rather closely the usual procedure in test construction.

It was also necessary to select a test to measure intelligence. For this purpose, the test selected was the *New California Short-Form Test of Mental Maturity.*

The following procedure was used in the administration of tests:

1. A Mathematical Literacy Test was given to all ninth grade pupils. These tests were given early in the school year. The time needed for administration of the test was two forty-five minute periods.
2. The intelligence tests were given to all pupils sometime in February or April.

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[6] *Ibid*

3. The Mathematical Literacy Test was given the second time to all ninth graders toward the end of the school year. The time needed was two forty-five minute periods.

All teachers were to continue their work in mathematics as they had planned, making no changes in content or methods because of participation in the study.

Mathematical Literacy in Terms Of Initial and Final Mean Scores

The 1923 Report listed in considerable detail the specific mathematical objectives necessary for citizenship. The Post-War Commission felt that if a person could say "yes" to the 29 questions (competencies) in the check list he might be considered mathematically literate. The evidence from this study indicated that the typical ninth grader, after having completed either algebra or general mathematics, does not have a mastery of the competencies and therefore may still be considered mathematically illiterate. After the algebra group had taken algebra one entire year, their mean score was 54.44; and the mean score of the the general mathematics group was 54.04. The test items numbered 110. One was discarded because of a typographical error. The highest possible score that could be attained was 109. The final mean scores for both groups would indicate that the typical mathematics student, after he had completed one year of his mathematics, has only a 50 per cent mastery of the essentials for functional competence in mathematics, as measured by the Mathematical Literacy Test. This would seem to indicate that a great number of pupils are continuing their high school training with quite an inadequate mastery of the 29 competencies. For pupils who complete their formal study of mathematics with the ninth grade course, this study shows that many are inadequately trained in common and useful mathematical skills.

The initial mean score for 562 algebra students in 46.54, and the final mean score is 54.44. This is a gain of *only* 7.90 points in the means of the algebra group on a test of 109 items. Similarly the means of the general mathematics group are 44.89 and 54.04 respectively. This is an increase of *only* 9.15 points. One of the important findings of this study was this astonishingly low gain in understanding and mastery of the 29 competencies, both in algebra and general mathematics. This would seem to indicate that there is a need for improvement of our programs of mathematics and mathematics teaching.

Mathematical Literacy in Terms of Relative Numbers of Correct Items

Let us analyze more in detail mathematical literacy or illiteracy

with relative numbers of correct items as criteria.

A Criterion of 100 Correct Items

If one might accept as a standard that 100 of the 109 items must be worked correctly to indicate mathematical literacy, then no one in either the algebra or general mathematics group may be considered mathematically literate, since 98 was the highest score obtained. Only one student, registered in general mathematics, obtained this score.

A Criterion of 90 Correct Items

If 90 correct solutions of the 109 problems be accepted as a criterion to indicate mathematical literacy, then three students in each of the two experimental groups demonstrated mathematical literacy in the final test. On the initial testing no one was found in this category.

A Criterion of 80 Correct Items

At this criterion the number of students that are mathematically literate in the four test administrations are as follows: initial algebra, 2; final algebra, 23; initial general mathematics, 4; final general mathematics, 32. In percentages these are 0.3%, 4%, 0.5%, and 4%. At this criterion, there is no appreciable difference between the two groups.

A Criterion of 70 Correct Items

At this criterion there was a noticeable percentage gain for both groups. In the algebra group the initial testing showed 7 per cent (41 students) in this class and on the final test it increased to 16 per cent (90 students). Similarly the general mathematics group changed from 3% (23 students) to 17% (128 students). At this standard approximately one in six would be mathematically literate after he had completed the ninth grade. Again, the percentages attaining this level for the final testing are about the same in the two subject fields.

A Criterion of 60 Correct Items

The number and per cent of students who attained literacy at this criterion level are as follows:

	Algebra		General Mathematics	
	Initial	Final	Initial	Final
Number of Students	111	197	106	260
Percentages	20%	35%	13%	35%

Again, the percentages for the final test are the same.

A Criterion of 55 Correct Items

It is interesting to note how many students passed 50% of the items. At this criterion 160 (28 per cent) of the algebra students (initial test), and 171 (23 per cent) of the general mathematics students (initial test) are mathematically literate.

Not quite one-half (49 per cent) of the students who finish ninth grade algebra or general mathematics are mathematically literate at even this low standard. At this criterion 273 (49 per cent) out of a total number of 562 algebra students (final test), and 358 (49 per cent) out of a total number of 734 general mathematics students can be considered functionally competent in mathematics.

It must be remembered that when a student has a choice of one in five for the correct answer to each item, he should get a grade of 20 per cent by guessing. It certainly is a fallacy to assume that ninth grade pupils entering an algebra or general mathematics class are proficient in minimum essentials in mathematics. This study provides ample evidence to show that the first eight years do not guarantee the mastery of the lower-order mathematical abilities and knowledge considered to be important by the commission.

A Criterion of 50 Correct Items

The number and per cent who attained literacy at this criterion level are as follows:

	Algebra		General Mathematics	
	Initial	Final	Initial	Final
Number of Students	229	360	263	446
Percentages	41%	64%	35%	79%

Conclusions

The most general and obvious conclusion that can be drawn from the study is that the vast majority of students are leaving the ninth grade with a woefully inadequate understanding and command of the essentials for functional competence in mathematics. It will be recalled that the Commission on Post-War Plans believes that the essentials for functional competence should be a part of the general education of all of our citizens.

The maintenance of democracy today is predicated upon the ability of large numbers of people to think clearly about problems that are essentially mathematical in nature. Therefore, a mathe-

matics curriculum should be established in every school to insure the basic mathematics needed for personal use for *all* citizens. This minimum requirement should be a mastery of the competencies. A course should be designed to provide these specific competencies. A mathematics curriculum may be built by locating and studying concrete problem situations which arise in connection with meeting needs in the basic aspects of living. After the student has acquired the minimum essentials, he then should be offered an opportunity for further mathematical training.

The State Superintendent of Public Instruction in Wisconsin recently issued *General Mathematics in the High School*, a mathematics bulletin recommending a sequence in general mathematics which provides for the development and maintenance of these essential competencies. An attempt should be made to evaluate this program in schools in which the guide is being used. We need other guides developed through experimentation which will aid teachers.

THE RADIOMETER AND THE INVERSE SQUARE LAW

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The well-known Crookes' radiometer equipped with the four-vaned paddle wheel lends itself to a number of *qualitative* demonstrations. With some care the device may be used in a *quantitative* demonstration of the inverse square law.

It is clear that the rotational speed of the vanes should be very closely proportional to the intensity of the radiation incident upon them. Accordingly, if a source of constant energy output produces an angular velocity ω at a distance d, this angular velocity should vary inversely as d^2. This can be shown with reasonable experimental error by using an incandescent lamp equipped with a reflector, such as a crook-neck desk lamp, and clocking the rotational speed of the paddle wheel. For close distances and a large lamp the speed, which may be too fast for the eye, can be gotten with a Strobotac. Since this contributes some radiation (quite negligible, however), the error introduced is easily eliminated by having it on throughout the experiment.

It is needless to say that we have more appropriate radiation (light intensity) measuring devices, but this demonstration is fun as well as informative.

Intelligent appreciation of situations is prerequisite to sound concepts and ethical conduct.—E. C. STAKMAN.

Spray gun, operating on the perfume-atomizer principle, is attachable to a garden hose. It mixes a liquid or wettable-powdered insecticide into the water stream and squirts the solution through a long nozzle which can be manipulated easily to reach those hard to-spray places.

THE SOCIOMETRIC TECHNIQUE AND THE TEACHING OF GENERAL SCIENCE*

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INTRODUCTION

It is common knowledge that there are many factors influencing the learning process. Among such factors are the child's physical make-up, maturity level, growth rate, family background, and his status with his classmates.

Of late, there has been increased concern with the importance of the social climate of the classroom as a factor in learning. By social climate is meant the feeling of social acceptance or rejection that students have for one another. Since formal learning takes place within a group setting, the educative process cannot be separated from this social atmosphere. This viewpoint is supported by Jennings[1] in this way:

> "All learning in school takes place within the setting of pupil-pupil relationships. Most teachers realize that the individual's personal and academic growth can be affected adversely or favorably by his position in the group and that all pupils stimulate or thwart each other in many ways."

It seems likely, therefore, that the social climate of the classroom will influence the learning process in all types of learning situations, whether it be in English, mathematics, science, or any other class. A search of the literature, however, fails to reveal many research studies that have dealt with the influence of social climate on the learning process. This is especially true of the field of science. Hence, it is the purpose of this study to determine the effects of certain sociometric teaching techniques, designed to alter the social climate of the classroom, on the achievement of an eighth-grade class in general science.

METHODS EMPLOYED

In order to determine the influence of the social climate of the classroom on the achievement of the students, it was first necessary to decide upon an effective method for measuring social acceptance or rejection of students by their classmates. Among such methods are (1) observational methods, in which the supervisor observes the group activity to determine the patterns of acceptance or rejection: and (2) verbal choice techniques, in which the subjects are asked

* A report of a thesis completed for partial fulfillment of the degree of Master of Arts at the University of Michigan, August, 1951.

[1] Helen H. Jennings, *Sociometry in Group Relations*. Washington, D. C.: American Council on Education, 1948, p. 1.

to name those with whom they would like to associate. The latter method was chosen for this study. In essence, the verbal choice technique, or the sociometric test as it is commonly called, consists of asking the members of a group to name the persons with whom they would most like to be associated in some specific situation. The "testing" situation must be spontaneous; the question must be well worded and casually presented; it must be concerned with a specific activity and the results should actually be used in that activity; and there should be good rapport between the administrator and the subjects.

The results of the sociometric test are usually interpreted by means of a sociogram. The sociogram is simply a graphic means of charting the students' choices of the test. It gives a picture of the choices, but does not reveal the reasons for the choices.

The Groups

The groups in this study were members of the eighth-grade class of a junior-senior high school in a small, suburban town in southeastern Michigan. They consisted of (1) an experimental group, and (2) a control group. The data concerning the characteristics of the groups are found in the following table.

Table I. Data Concerning Characteristics of Groups

Group	Number in Group	Age Range	Mean Age	Range of Raw Scores on Mental Test*	Mean Raw Score on Mental Test	Mean Number of Years in System
Experimental	28	13–16 years	14 years, 5 months	45–101	72.43	5
Control	30	13–16 years	14 years, 3 months	49–95	71.17	5

* The test used was the California Short-Form Test of Mental Maturity, Intermediate 1950 S-Form.

An examination of the data in Table I indicates that the ranges and means of the factors considered are quite similar for both groups. Hence, for purposes of this study, the two groups were considered to be equal with respect to these factors, namely mental ability, age, and number of years in the school system.

Plan of the Study

The control group was taught in the usual manner, without emphasis on the social climate of the group. The experimental group was taught with a conscious effort to improve the social status of the

students. Then, by comparing the science achievement scores of the two groups at the end of the investigation, it was hoped that some indication might be obtained as to the effect of sociometric teaching techniques on achievement in general science. Since the two groups were equal with respect to certain other factors, any difference in achievements might be due to differences in the social climates in the two classes.

In order to determine the achievement in science, The Cooperative Science Test for Grades 7, 8, and 9, Form Y, was administered to the groups. The test was administered to the experimental group at two different times (1) at the end of the first semester of the eighth-grade (January); and (2) at the end of the second semester of the eighth-grade (June). The difference between the two sets of scores was used to indicate any change in the achievement of the group during the semester in which the study was conducted.

At the end of the second semester of the eighth-grade (June), the test was also administered to the control group. The scores made by the control group were then compared with those obtained by the experimental group in June to give an indication of any differences in achievement between the two groups. The data obtained from these tests are analyzed later in the paper.

The groups were also administered a sociometric test to measure the social climate of the classrooms. The experimental group was given two sociometric tests, one at the end of the first semester, and another at the end of the second semester. The first test was delayed until the end of the first semester to give the students an opportunity to become well acquainted with one another, and also to allow time for the establishment of good rapport between the students and the instructor. The test was presented for a specific situation, and the results of the test were used in the classroom. The test question was presented to the experimental group in January as follows:

"Next week we are going to work in groups of two three to give demonstration experiments for the class as part of our semester review. We all know that we work better if we are with people whom we know and like, and so I am going to try to arrange you in a group of people with whom you would like to work. To help me do this, will you please write your name on the top line of this card and then write the names of your first, second, and third choice of working partners. Remember that you may also choose any people who are absent today. I am the only person who will see your cards. From the information on the cards, you will then be placed in groups or two or three to work on the experiments. All of you may not be able to work with the person who is your first choice, but you will be with at least one of the partners whom you choose."

File cards (three by five inch) were then distributed, the students were given sufficient time in which to indicate their choices, and the

cards were collected. The information thus obtained was used to construct a sociogram for the class.

During the ensuing semester various sociometric techniques were employed in an attempt to improve the social climate of the class as a whole. Wherever possible the individuals who had received few choices were placed with some of the "stars" of the class in various working situations. For example, when experiments were performed in the class in which it was necessary to have the students work in small groups, the small groups were arranged so that the isolates were placed with one or more of the stars whom they had chosen in the sociometric tests. Responsibility for the care of laboratory equipment and the construction of simple apparatus also afforded opportunities for assigning certain students to work together and thus draw certain members into the group. Three times during the semester the seating arrangement of the classroom was changed in an attempt to improve social status. In all of these cases, however, it was attempted to execute these changes within the normal classroom atmosphere, without creating an artificial situation.

At the end of the second semester the experimental group was again given a sociometric test, very similar to the one in January. Hence, by comparing the results of the two tests, an indication was obtained on any changes in the social climate of the group.

A similar sociometric test was administered also to the control group at the end of the second semester. However, no conscious effort had been made to improve the social climate in the classroom of the control group previous to the administration of the test. By then comparing the results obtained from the control group with those of the experimental group in June, it was hoped that some indication might be obtained of the effect of the sociometric techniques employed in the teaching of the experimental group.

Data Obtained

The data obtained from the science achievement tests are found in Table II:

Table II. Ranges and Means of the Total Scaled Scores of the Two Groups on the Cooperative Science Test, Form Y

Groups	Range of Total Scaled Scores	Mean Total Scaled Score
Experimental Group, January	40–77	53.64
Experimental Group, June	40–79	56.11
Control Group, June	43–71	54.13

The significances of the differences betwen the January and June test scores of the experimental group, and the June test scores of the experimental group and the control group were calculated by using Fisher's "*t*." This technique is cited by Guilford.[1]

The results of the calculations are found in Table III:

TABLE III. SIGNIFICANCES OF DIFFERENCES BETWEEN TEST SCORES OF THE TWO GROUPS ON THE COOPERATIVE SCIENCE TEST

Groups Compared	Mean Difference	σ Difference	"t"	Probability Level	Interpretation
Experimental Group, January test and June test	2.47	2.09	1.18	$P > .05$	Not significant
Experimental Group, June test and Control Group, June test	1.98	1.98	1.00	$P > .05$	Not significant

The results obtained from the sociometric tests are found in Table IV:

TABLE IV. DATA OBTAINED FROM THE SOCIOMETRIC TESTS ON THE TWO GROUPS

Groups	Number of Students Receiving One or More First Choices	Number of Mutual Choices	Number of Isolates	Largest Number of Choices Received by Any One Student	Number of Choices between Boys and Girls
Experimental Group, January	16	5	5	10	2
Experimental Group, June	18	16	3	7	0
Control Group, June	19	11	3	7	3

The data obtained from the sociometric tests indicate an apparent improvement in the social climate of the experimental group from January to June. In so far as could be measured by the test, however, there appeared to be little difference between the social climate of the control group and that of the experimental group in June.

CONCLUSIONS

In so far as the techniques used in this study may be valid, the following conclusions seem justified:

[1] Joy P. Guilford, *Psychometric Methods*. New York: The McGraw-Hill Book Company, Inc., 1936. Pp. 61–62.

1. There was a gain of 2.47 points in the mean of the total scaled scores of the experimental group on the Cooperative Science Test from the first test to the second test. This difference, however, was not statistically significant. Hence, it cannot be assumed that there was any appreciable gain in the achievement of the group during the second semester, at least in the factors measured by this test.

2. The mean of the total scaled scores of the second testing of the experimental group on the Cooperative Science Test was 1.98 points higher than the mean of the total scaled scores of the control group on the same test. Hence, it cannot be assumed that the experimental group had a greater achievement in science than the control group, at least in the factors measured by this test.

3. There was no appreciable difference between the social relationships of the experimental group as compared with those of the control group, as indicated by the sociometric test administered at the end of the eighth-grade. However, there was no way of testing any changes of attitude that may have been brought about by the use of the sociometric techniques used with the experimental group.

4. According to the second sociometric test administered to the experimental group, there were three isolates and sixteen mutual choices indicated, as compared with five mutual choices and five isolates on the first test. There was also an increase of 17.15% in the number of students receiving first choices from the first test to the second. Hence, there was a slight improvement in the social climate of the experimental group during the second semester.

5. From the conclusions just stated, it seems reasonable to assume that using the sociometric techniques for one semester, in the way indicated in this study, does not produce any significant gain with respect to achievement in general science. However, there was an improvement in the number of desirable social relationships in the class and in the attitudes of the students. The significance of these, however, could not be determined statistically.

Recommendations

In so far as the conclusions in this study are defensible, the following recommendations seem justified:

1. Although significant changes in social relationships were not indicated generally in this study, it is recommended that sociometric techniques might be employed to a greater extent in an attempt to improve the social relationships among certain members of a class.

2. It is recommended that for greater effectiveness, sociometric teaching techniques be employed for a longer period of time than was the case in this study.

THE TEACHING OF COLLEGIATE MATHEMATICS

AARON BAKST
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The following letter is another of a series which SCHOOL SCIENCE AND MATHEMATICS has been presenting on the teaching of collegiate mathematics. Following the general plan, this is again phrased in the form of a letter which might be written by an experienced teacher to a young colleague just starting his career. This letter is by Dr. Aaron Bakst. Dr. Bakst has written several books, among them *Mathematics, Its Magic and Mastery* and *Approximate Computation*, the 12th yearbook of the National Council of Teachers of Mathematics.

CECIL B. READ,
Mathematics Editor

Dear Dick:

So, you finally landed a job in a College. Congratulations and best wishes. I knew all the time that your work in mathematics will help in getting what you wanted all these years. Now, do let me offer you a few frank observations and some "brotherly advice."

I read the abstract of your doctoral dissertation with interest. You have done some very good spade-work. The personal comments of your advisor should make you proud. But now, destroy all this pride. . . . If you are a research man, your dissertation is only the first step. And if your are a research man, do not bring this into your undergraduate classes, unless you can come down to the level of your students. You see, Dick, to do research is one thing, and to be a successful teacher is an element of another "set." Do not permit your doctoral study to eclipse your objective as a teacher.

You will come in close contact with a variety of students. The preponderant majority of them will not be of the "pure mathematician" caliber. Do not try to approach them as if mathematics is the one and only subject in the college curriculum. Keep in mind that many of your students are not favorably inclined toward mathematics, that they are taking one prescribed course in order to meet graduation requirements. Do not try to teach them everything there is to mathematics. You will alienate them from you (and this is a calamity), but you will alienate them from mathematics (and this is a tragedy).

When you enter your first class, do not be a sourpuss. Smile, even if this hurts your pure mathematics feelings. You will not teach prospective mathematicians, by and large. The prospective mathematician will learn mathematics in spite of you. The layman may not learn *about* mathematics because of you. You will be told to use a textbook. You may be given the opportunity to voice your opinion concerning the book. Rememember, however, that teaching, if it is to be successful, is not a blind following of a book. Also remember that the development of the techniques for solving problems is not

learning mathematics. True, you will have to administer tests, make assignments, and give grades. But, the passing of a course should not be predicated on being able to solve problems and reproduce some proofs.

Develop a sense of humor. Learn how to capitalize on situations which are ever-present in and out of a classroom. Learn what the students are doing in other courses and try to bring up the current situations in your classroom. This will make your teaching more effective than any proof or exercise from a textbook. Ask your students to see how mathematics operates in other fields, and build your subject matter around such little things. They may seem little to you because they are removed from direct contact with mathematics. Learn how to detect a mathematical background in them. Read the mathematical literature. But also read the literature in other fields. Remember, you cannot stop learning. If you stop, you will go stale. Make capital of every available situation. You will be surprised how big things grow from seemingly insignificant situations.

And be humble. The fact that you have earned a Ph.D. degree does not set you apart from others. I always tell my students who prepare to become teachers that there is one best book on Educational Psychology. I refer to the Good Book. Have it always opened to the Sermon on the Mount. Remember: "Ye are the salt of the earth." This means you—you have attained the heights in mathematical research. But do you remember: "Blessed are the meek."? This is meant for you too. Help your students to learn and to learn to love mathematics, even if they are not mathematics majors. Mathematics is not a difficult subject. I remember one of my professors (one of the top men in our field) who told me: "It is not a crime to take a difficult thing and make it easy. But it is an unpardonable sin to take an easy thing and make it difficult." Some of the young mathematicians who enter their first class display an attitude of impatience with the "dullard." Lead him by the hand. He will never bite your fingers for that.

I remember one incident which occurred during my undergraduate years. While walking along the campus I overheard one student asking his friend: "Are you taking the course with Professor X?" (He mentioned a very "big name" in mathematics.) "No", replied the other, "I am not taking the course, he is *giving* it to me." Let that not happen to your students. . . .

Well, good luck to you. You will need it. But if you want to make it a certainty, be alert, be human, and, above all, place yourself where your students will be. You will find there plenty of company.

Sincerely yours,

AARON BAKST

CONCERNING ROCKET SHIPS AND SPACE TRAVEL

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A number of inquiries have come to me in recent days from school children and from teachers. It seems that the youngsters have asked some questions! Not a few mentioned some movies they had seen in which rockets and space ships figured, and their questions centered around the possibility of what the cinema craftsmen showed photographically. One referred to certain events in a comic strip and wondered about the physical possibility. (Parenthetically, if the movies and the comics stimulate *this kind of inquiry* among the younger generation I cannot too much condemn them, although there is still a hefty argument for more of the old-fashioned 3 R's and less movies and comics!) All of this, then, has pointed up the advisability of a brief essay for high school teachers and their charges, in which I hope to clear away the misconceptions, show what we can *now* do, and point up the achievements which some of us will probably witness before our day is done.

First we must correct the misleading and indeed utterly erroneous conception and opinion which, I regret to say, not a few possess. *It is that the rocket needs air to push against. This is not so.* The rocket ejects from its tail a blast of gas and the recoil from this blast provides the driving force. As a matter of fact the atmosphere is its worst obstacle, and once out of it the "sailing will be quite clear."

Another confusing detail is the distinction between jet propulsion and rocket flight. *In jet propulsion we need the atmosphere* since air is taken in at the nose of the missile or ship and this air aids the oxidation of the fuel in the combustion chamber. From this point on the emerging blast of gas provides the motive power, as in the pure rocket mechanism.

The greatest achievement so far in rocket performance is the advance on the German V-2 at White Sands. The original (a spoil of war) was propelled by the combustion products of alcohol. It carried about 1000 gallons of liquid oxygen and about the same quantity of alcohol. It was about 50 feet long and nearly 6 feet in diameter and weighed close to 15 tons. It was propelled for a little over 60 seconds but continued in flight for some 5 or 6 minutes. The maximum velocity it attained was about 1 mile per second. The maximum power developed took on the staggering figure of about half a million horsepower! The height reached was a little more than 100 miles. This has since been improved on by some 25 to 50 miles.

The V-2 rockets proper are referred to as single- or single-stage rockets to distinguish them from the two-stage and three-stage rockets

now under development. In these multiple-stage mechanisms, as the reader might readily deduce, the rockets are hitched in tandem, one behind the other. When the lowermost one has acquired its greatest velocity the one ahead of it is fired, or, more properly, ignitioned, and the flight is continued by the forward assembly. When the second mechanism acquires its highest velocity the third is ignitioned, and so on. So far only the dual mechanism has been sensibly perfected and the height reached is something over 250 miles. This is pretty well at the upper limits of our atmosphere, if not altogether beyond it. (Although the upper limit of the earth's atmosphere is not well defined, the pressure above 50 miles is quite inappreciable, and since the compressibility of air is so great more than half the mass of the atmosphere is below 4 miles and about 97% is below 18 miles.)

It appears altogether workable then, that in the not-too-distant future we shall have multiple-stage rockets capable of indefinite flight *upwards*. This dismisses the problem heretofore encountered, namely the "escape velocity" from the earth, which is about 7 miles per second. Further, the take-off will not involve the suicidal acceleration which has heretofore appeared insurmountable to men. It is this fierce *change in velocity* which constitutes the greatest human hazard, but with the multiple-stage mechanism moderate take-off speeds within human endurance can be achieved. As we get farther and farther from the earth and the gravitational pull of the earth diminishes (it falls off as the square of the distance) a feeling of "weightlessness" will arise, but this can be compensated for. All we need do is accelerate our machine and Newton's Third Law will provide an *artificial* gravity!

It is safe to say then, that we shall be able to get off the earth to any height we wish. This means that we can visit the moon, and flight to the other planets is not mere fantasy. We may soon see it.

But there is one thing we shall likely achieve first and this ambition is really not far from realization. We will have an artificial satellite above the earth! Let's look into the scheme:

First we get to the desired height above the earth, by "shooting" *vertically* upwards. This is now certain as a possibility. Then we must turn the ship at right angles to its course "upwards" so that it travels "parallel" to the earth. This can be provided by internal mechanisms. Now a number of troublesome but not insurmountable problems arise:

1. How far up do we want to go? Where do we wish this ship to sail? That is, at what distance from the earth? What is the radius of its orbit? This is answered as follows: It will be above the atmosphere, certainly. Since the resistance to flight is negligible or in truth does not exist at all, no fuel is required *after it gets there*. It will sail smoothly above the earth and around it just like the moon. Is the moon

powered? The speed it will have in its orbit will be the speed it possesses at the moment it is turned into its orbital path. This will be calculated in terms of the distance from the earth and the centrifugal force necessary to outwit the earth's gravitational pull. The farther from the earth, obviously, the slower it can go; the nearer, the faster it must go. And the orbital radius it has will obviously govern its time of flight about the earth, that is, its period. If the proper distance is achieved, and the speed that goes with it, its period could well be the time of rotation of the earth. It would then have the appearance of being fixed in space for it would always be "above" any observer's station on earth.

2. How big will this ship be? Will it be manned? The first "rocket-planet" will obviously be experimental and only electronically equipped. The present difficulty is appropriate fuel. But with atomic energy already on the horizon we shall certainly see a sizeable ship, man-powered. It is conjectured that once we get a section or small ship orbitally located other sections can be sent up and assembled *there*. Who will assemble them? Why men, of course, They will be equipped with pressure suits and atomic energy jets so that each can navigate in the space around the ship and do his work, either inside the ship or outside. It may be a safety requirement, however, that every man be tied to the parent ship for a very obvious reason. The slightest miscalculation in jet action will send him away forever, since, you will recall, there is no resistance to flight!

Now, lastly, what will this satellite provide us? The answers are legion. Astronomers will find there a haven—no atmosphere to bog down their efforts. The depths of the universe can be explored and the riddles of space deciphered. Relay stations for TV and radio can be established. Cosmic radiation can be studied. The sun's mechanism can be looked into. What will be learned and achieved will stagger the wildest imagination—but we are already in a day where the maddest impossibility is done tomorrow.

It is my own conviction that whatever the human brain can think of or speculate on can be achieved. There is no fiction!

Already unmanned rockets and balloons have penetrated the upper regions of our atmosphere quite beyond any piloted flight. These "flying laboratories" are truly amazing things. They carry cameras and radios and Geiger counters and spectrographs, all of which return to earth with mountains of data. We can now take man up to about 25 miles in *perfect safety*. A hazard we run beyond this is the unknown effects of cosmic radiation at higher altitudes. But once this is known we will develop protection against it.

Who wants to sign up for the first trip to the Moon?

AN EXPERIMENT IN THE INTEGRATION OF MATHEMATICS AND SCIENCE

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The one question that is raised in a mathematics class probably more often than any other one question is the query, "What good is this; when will I ever use it?" Unfortunately the answer to this question is frequently one of the least satisfactory explanations given in the entire course. Perhaps many mathematics teachers have too limited a background in science, economics, and other subjects to suggest specific applications of mathematical principles in other fields. Yet, how much more convincing it would be if the student could actually use some of his mathematical principles in solving his own current problems instead of merely listening to a discussion of what he may do several years hence!

On the other hand, probably the most common complaint of the science teacher is the poor mathematical background of his chemistry and physics pupils. Yet, he continues to complain and to use his time to teach the required mathematical processes without enlisting the aid of the mathematics teacher!

Both of these regrettable situations could be avoided and both courses could be enriched by a little closer correlation between them. Several mathematical processes are needed in chemistry and physics before they are encountered in the average algebra and trigonometry texts. The science teacher, therefore, has to interrupt his own work to review or teach these topics, but unless he is also a mathematics teacher, he will probably teach merely the mechanical processes (in terms of transposition, cancellation, cross multiplication, etc.) that are needed to find the answers.

As a consequence these science students often consider the mathematics teacher, as well as the entire subject, dull, tedious, and useless when she attempts to develop these solutions, some months later, in a logical manner and in the proper sequence. For these students this is like reading the last chapter of a book first—they are waiting for the teacher to catch up with them. Moreover, the mathematics teacher has by this time lost one of the most abundant sources of practical applications available. Most problems presented at this time are also repetitions of what the students have already learned elsewhere. The enthusiasm of learning something new has been associated with the scientific principle; the mathematics is still only incidental. Thus, the students' general impression is that the only practical mathematics is that which they learned in science rather than in the mathematics class.

While the writers of this article were teaching mathematics and science respectively in the same high school, this common lack of cooperation between the two departments was noted, and an organized program to correlate advanced algebra with chemistry and trigonometry with physics was undertaken. First the science teacher outlined the topics he intended to teach in each course with the approximate date on which he expected to begin each topic and the mathematical processes needed for each one. Then the mathematics teacher compared this outline of required mathematical skills with her syllabus for each course. All the processes that would normally be reviewed or introduced by the time indicated in the science outline were checked off. Any others that were not ordinarily covered by the specified time but could be introduced sooner, to a limited extent if necessary, were put into the mathematics outline with an earlier related topic. Finally, if there were any other processes required that could not be profitably introduced by the date suggested, the science teacher postponed that topic until a later time.

Perhaps a few specific illustrations will help to clarify this entire correlation program. For example, this mathematics teacher always reviewed all types of simple equations at the very beginning of the advanced algebra course, so her students would normally be able to handle formulas and chemical equations as soon as desired. Thus, the solving of simple equations was checked off of the science teacher's list as a requirement already met. Ratio and proportion, however, which are usually considered late in the course in connection with functions and variables, were needed for chemistry problems involving the gas laws and weight-weight and weight-volume relationships long before that time. Since a proportion is only a particular kind of fractional equation, it was quite simple to review or introduce proportions (depending on the elementary algebra background of the pupils) with the early review of simple fractional equations.

Similarly, logarithms were reviewed or introduced early in the trigonometry course so that the physics pupils might use logs and slide rule for computation throughout that course. On the other hand, neither the sine curve, which is needed for the study of A.C. currents in electricity, nor the sine law, needed in the solution of a parallelogram of forces, could be meaningfully introduced before the functions of larger angles. Therefore, both of these topics in science had to be postponed until the necessary background in trigonometry could be developed. However, the mathematics teacher did introduce large angles and obtuse triangles much earlier than her text suggested by taking up that unit before identities.

This correlation project was finally climaxed in the spring in an

assembly program arranged by the science department in which the beauty of mathematics rather than its practical value was emphasized. One of the demonstrations included in this program was the use of a "black light" source on phosphorescent paints and materials. Therefore, several of the original designs made previously by the plane geometry students as a regular assignment in connection with compasses-and-straightedge constructions were selected. Then, during mathematics club or other free time these students enlarged their designs on cardboard (an excellent exercise in proportion) and outlined them with various colors of the phosphorescent paints and pencils. Thus, what appeared to be blank or nearly colorless posters around the stage during the forepart of the assembly became strikingly beautiful geometric designs when illuminated with the "black light" source.

The results of this experiment were highly gratifying to both teachers. The science teacher could devote his attention entirely to the development of scientific principles, knowing that the students would have the necessary mathematical background to follow his presentation. He was also able to present considerable additional material that he had previously been unable to cover.

The mathematics teacher was prepared with a ready answer whenever the question of usefulness arose, or better still, was able to prevent this negative thinking on the part of the students by discussing briefly an appropriate application of a new principle when it was introduced. Moreover, she now had an abundant supply of practical applications from which to draw review problems after the related scientific principle had also been developed. (Although no organized program was developed with the commercial, industrial arts, or machine shop teachers, many helpful applications were also found in these subjects.)

More important than any of these results, however, was the attitude of the pupils. These pupils were actually surprised to find that the mathematics they learned in the mathematics classes was the same mathematics that they used in chemistry and physics. The typical comment heard repeatedly by both teachers was, "This is the first time in my life that I have ever found that what I learned in one subject helped me in another." Of course, this should not have been a true statement for they should have observed the relationships between history and geography, English and other languages, English and secretarial courses, and so forth long before, but unfortunately this was a sincere and in many cases a correct remark.

In addition, without detracting any interest from the science course, mathematics for these students had become the vital, timely,

and therefore, interesting subject that it should be. Nearly every topic could be related to some need in the foreseeable future, so it was important that it be mastered.

Incidentally, this also eliminated many guidance problems at the following registration. The few capable students who had insisted on electing advanced science classes without the advanced mathematics soon observed that the mathematics students had a definite advantage under this setup, and news of this spread rapidly. It might also be mentioned that none of these students who entered college had any difficulty with mathematics or professional-preparatory science, and some of them even passed college proficiency tests in both subjects.

Of course a project of this kind involves greater long-range planning in both science and mathematics than is usually required. It also presupposes that both of the teachers are sufficiently familiar with their subject matter to know the necessary prerequisites for each topic. It requires a very careful choice of illustrative and drill materials, particularly in the case of topics introduced earlier than usual. Nevertheless, the writers felt that the benefits in this and subsequent similar correlation programs far outweighed the additional time and work required.

A CONTROL FOR ALGAE BLOOM

A chemical which promises to be of aid in controlling the bloom of noxious blue-green algae in lakes during summer has been given initial its testing by University of Wisconsin botanists.

The botanists are George Fitzgerald, Gerald C. Gerloff, and Folke Skoog. The chemical was among 300 substances screened for effectiveness as an algae poison in comparison with copper sulphate now extensively used as a lake algaecide.

The chemical is selective in its action, and only a few parts per billion are required in laboratory tests for a lethal effect on the species of algae most susceptible to the poison. These species are the blue-green bloom-producing algae responsible for many of the unpleasant effects of heavy summer growth in lakes. Some other species are killed by the chemical, but only by concentrations much higher than needed to kill the blue-greens.

"With one exception, only the bloom-producers of all 20 species of algae upon which the poison was tested were killed by concentrations of less than 10 parts per billion," the scientists reported.

The search for a selective algae killer became possible after methods for culturing the blue-green algae species in the laboratory had been worked out, a discovery announced by the U.W. scientists last year. The research was financed by the Wisconsin Alumni Research foundation and the National Institutes of Health.

TEACHERS COLLEGE APPOINTS ROSSKOPF

Teachers College, Columbia University announces the appointment of Myron F. Rosskopf as Associate Professor of Mathematics, effective July 1, 1952. Dr. Rosskopf comes from Syracuse University, where he was in charge of the training of mathematics teachers.

AN OBJECT FOR DETERMINING THE FOCAL LENGTH OF LENSES

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No laboratory course would be complete without one or more experiments on the determination of the focal length of a lens. The usual method is to use some illuminated object, and by means of the lens cast an image of the object upon a properly placed screen. The distance from *object* to lens, p, the distance from the lens to *image*, q, and the *focal length* of the lens, f, are then related by the equation

$$\frac{1}{p}+\frac{1}{q}=\frac{1}{f}.$$

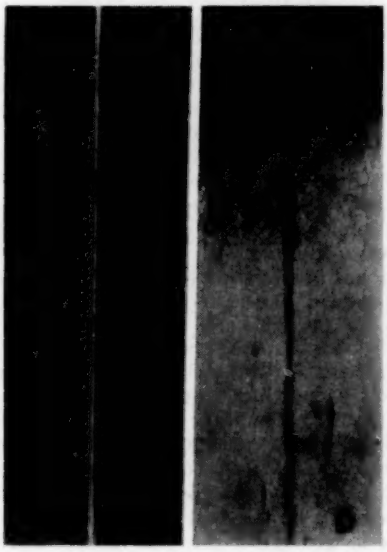

FIG. 1. (W) White line due to crossed rays. (D) Dark line due to obscurity behind dividing line.

In all of these experiments we are dependent upon our judgment as to when the image is sharply in focus.

In working with a Fresnel bi-prism some years ago I noted that as a lens was moved toward or away from the dividing line of the two surfaces inclined to each other by a small angle, the image of the line snapped suddenly from a white to a dark line, Fig. 1, as the lens was moved back and forth. This was particularly striking when one used sunlight, the most nearly parallel rays which one can obtain. The moment the lens was far enough from the bi-prism to get the

crossing of the rays the white line appeared, and the moment the lens came back to what was hidden behind the dividing line a dark line appeared. No judgment was needed about when one disappeared and the other appeared. The slightest movement of the lens made the change instantly. The dividing edge between the two surfaces of the bi-prism made a good point from which to measure p. A good bundle of parallel rays of light seems to be essential for the best working of this method. A bundle of such rays may be obtained from the sun by means of a heliostat.

NORTHERN ALASKA EXPLORATION SHOWS VAST OIL AND GAS RESERVES

WADSWORTH LIKELY
Science Service Staff Writer

Hundreds of millions of barrels of oil and large amounts of natural gas are under the ground in northern Alaska, Science Service learned.

The recent drilling of 31 test wells has shown that the area north of the Brooks Range up to the northern coast of Alaska may well prove to be one of the great oil basins on American soil. Extensive work has been done in the last four or five years by both the U. S. Geological Survey and the Navy on what was already recognized, superficially, as promising prospecting territory.

However, you had better not pack your prospecting instruments and set off up the Alcan Highway tomorrow. All of the possible oil fields are well within the Naval Petroleum Reserve Number Four, off limits to private development.

Estimates of the amount of oil and natural gas in this basin are based on wells which have actually produced both products. Measurement of the rate of production of these wells enables geologists and prospectors to make a rough guess as to the size of the oil fields below the wells.

One indication of the worth of the oil basin is to compare it with the rich new Alberta, Canada, fields. It was not until 215 wells were drilled that oil was actually found there. On the arctic slope of Alaska, prospectors found one large oil field with four wells at Umiat, one small field with two wells at Simpson, one well with unknown reserves at Fish Creek and five gas wells in three fields. All this was done by drilling only 31 test wells, as contrasted with the 215 in Alberta.

The Umiat field seems to be the best discovered so far. On the basis of oil already produced there, geologists estimate that 30,000,000 to 100,000,000 barrels of oil are in that field alone.

The most promising area, from a geological standpoint, has not yet been test drilled. This is in the foothills, just to the north of the Brooks Range and south of the area where the 31 test wells have been drilled. If test wells, soon to be drilled there, live up to their promise, experts say, there will be fields in the foothills bigger even than Umiat.

Despite the cold and the permafrost, experts believe this oil will be relatively easy to get at. In such temperatures, the "pour point" of the oil is the important factor. The oil in Umiat is still pourable down to minus 15 degrees Fahrenheit. That at Simpson is not so good—its pour point is plus 25 degrees.

The wells are generally 150 miles from an ice-free coast and pipe lines could easily be built for this short distance.

When the fields in this vast area are all delineated, experts believe, hundreds of millions of barrels of oil will be added to the nation's 20 billion barrels of oil reserve already discovered.

EQUATIONS INVOLVING RADICALS

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For most points discussed in high school algebra and freshman college mathematics problems can be readily formulated or quickly found in a textbook, This is not the case with equations involving radicals which lead to quadratic equations. Even with the aid of a textbook, problems with the desired qualities are not always obtained. The following paragraphs present suggestions which should help the teacher in obtaining equations which produce rational numbers as possible roots. These possible roots may satisfy or be extraneous as the teacher wishes.

Consider the equation

$$\sqrt{Ax^2+[(B^2-A)(r_1+r_2)+2BC]x-(B^2-A)r_1r_2+C^2}=Bx+C.$$

When either of the possible roots, $x=r_i$, $i=1$ or 2, is substituted the result is

$$\sqrt{(Br_i+C)^2}=Br_i+C.$$

Thus, both roots satisfy if $Br_i+C\geqq 0$, $i=1$ or 2, while neither satisfies if $Br_i+C<0$, $i=1$ or 2. One value satisfies while the second is extraneous if $Br_1+C\geqq 0$ and $Br_2+C<0$. For example, choose $r_1=3$ and $r_2=-1$ to be possible roots of an equation and let 3 be a root, but -1 be extraneous. Choose A arbitrarily as 5, B and C as 2 and -3 respectively so that $(2)(-1)-3<0$, but $(2)(3)-3>0$. These values substituted in the form equation produce

$$\sqrt{5x^2+[(4-5)(3-1)+(2)(2)(-3)]x-(4-5)(3)(-1)+9}=2x-3,$$

which is

$$\sqrt{5x^2-14x+6}=2x-3.$$

This is an equation suitable for students to solve.

A general equation involving two radicals is

$$\sqrt{(r_1+r_2+2A+B)x+\left(\frac{2A+B}{2}\right)^2-r_1r_2}$$
$$\pm\sqrt{(r_1+r_2+2A-B)x+\left(\frac{2A-B}{2}\right)^2-r_1r_2}=B.$$

The conditions for producing real or extraneous roots are determined by substituting r_i, $i=1$ or 2, for x. If the plus sign is choosen, r_i,

$i=1$ or 2, will satisfy if

$$\frac{B}{2}-|A+r_i| \geqq 0,$$

but will be extraneous if the expression on the left is less than zero. When the sign between the radicals is choosen negative r_i, $i=1$ or 2, will satisfy if

$$A+r_i-\left|\frac{B}{2}\right| \geqq 0,$$

but will be extraneous if

$$A+r_i-\left|\frac{B}{2}\right|<0.$$

For an equation involving three radicals one may use

$$\sqrt{A[2B+A(r_1+r_2)]x+B^2-A^2r_1r_2}$$
$$+\sqrt{C[2D+C(r_1+r_2)]x+D^2-C^2r_1r_2}$$
$$=\sqrt{(A+C)[2B+2D+(A+C)(r_1+r_2)]x+(B+D)^2-(A+C)^2r_1r_2},$$
$$AD \neq BC.$$

Substitution of r_i, $i=1$ or 2, for x produces

$$\sqrt{(B+Ar_i)^2}+\sqrt{(D+Cr_i)^2}=\sqrt{(B+D+Ar_i+Cr_i)^2}.$$

From this it is seen that the equation is satisfied by the value substituted if $B+Ar_i$ and $C+Dr_i$ have the same sign, otherwise the root will be extraneous.

REPLACEMENT PARTS IN RIDER MANUALS

John F. Rider Publisher, Inc., 480 Canal St., New York 13, N. Y. will list replacement parts in connection with service information in RIDER MANUALS and RIDER TEK-FILE. This applies to TV, Radio and other equipment which will come into the hands of service technicians.

This program will commence with the servicing data being prepared for RIDER TELEVISION MANUAL VOLUME 10 and with TEK-FILE beginning with TV Pack 57, which series will appear in May.

RIDER TEK-FILE Packs containing Radio servicing data only, are now in production. When they appear, they too, will contain replacement parts listings.

Every replacement part listed in Rider servicing data is guaranteed to meet the physical and electrical performance ratings of the original equipment used in the receiver. The Rider organization and the participating parts manufacturers back this guarantee to the service technician with the promise of a complete refund

STANDING WAVE DEMONSTRATIONS

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When discussing the various types of standing waves in a physics class, it is often helpful to use various types of demonstration equipment. As an aid in the teaching of transverse, longitudinal, and electromagnetic waves, the apparatus shown in Fig. 1 has proved helpful at William Jewell College.

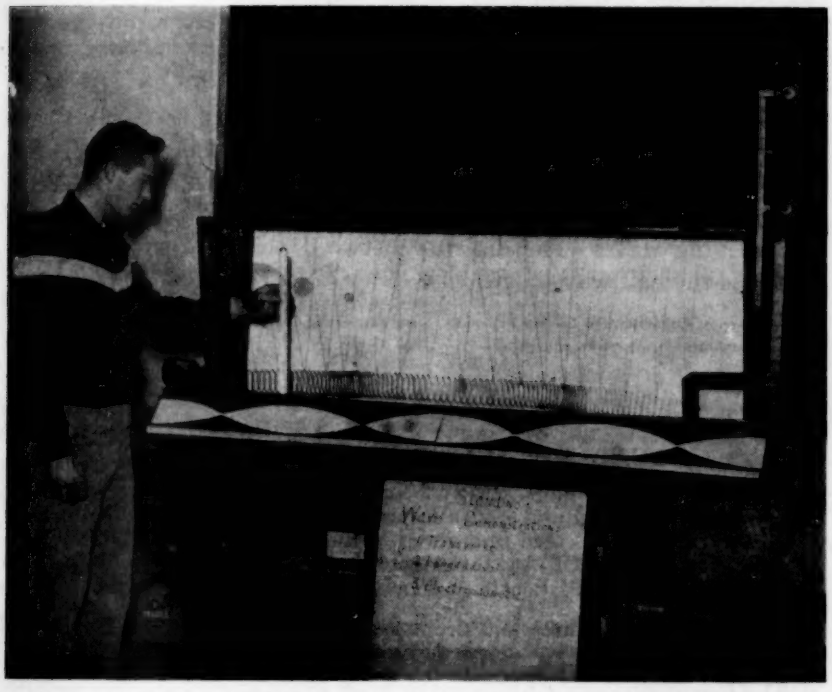

FIG. 1. Apparatus for the demonstration of transverse, longitudinal, and electromagnetic standing waves.

Transverse waves are demonstrated by using a mechanical oscillator[1] attached to a small motor. Three strings are attached to the oscillator with weights of 50 grams and 200 grams on the two horizontal strings respectively. On the vertical cord a 50 gram weight is attached after the string has been looped over a pulley. All three strings are of the same length. The speed of the motor is controlled by a variable transformer and is usually adjusted so that the 50 gram vertical string (only lower part is shown in Fig. 1) vibrates in one

[1] Central Scientific Company, Catalog J-150, Item 74565, p. 1068.

segment. Then the 50 gram horizontal string vibrates in two segments and the 200 gram horizontal string vibrates in one segment. The ratio of the frequencies of the horizontal and vertical 50 gram strings may then be studied as well as the ratio of the weights of the two horizontal cords.

The apparatus for showing compressional or longitudinal waves has been suggested by Rogers[2] at the Iowa State Teachers College. A tumbling spring[3] is suspended horizontally in a box made of plywood. A laboratory mechanical vibrator or rotator is connected to one end of the spring and by careful adjustment of the frequency, standing compressional waves may be observed. By removing the small box at the other end of the coiled spring, standing waves reflected at a free end may be observed.

Electromagnetic waves are demonstrated by using a very high frequency oscillator, which in this case is a 200–500 megacycle oscillator. A Lecher-wire system, made out of iron rods about six feet in length is used. An ordinary fluorescent lamp is used as a detector of the standing waves. The distance between points of maximum intensity is the half wavelength.

[2] R. A. Rogers, Colloquium of College Physicists, State University of Iowa, June 15, 1950.
[3] W. J. Cunningham, *American Journal of Physics*, Vol. 15, pp. 348–52.

FILMS FOR AGRICULTURAL STUDENTS

Six new full-color, full-length and fine quality filmstrips of tremendous importance to all agricultural students, farm groups and future farmer organizations have just been released in a group of three series entitled SELECTION OF BREEDING STOCK by the Audio-Visual Division of Popular Science Publishing Company, 353 Fourth Avenue, New York 10, New York.

Fully covering beef, sheep and swine, each of the three series consists of two natural-color filmstrips—one devoted to the male and the other to the female—that enables teachers and discussion leaders to bring into their classrooms hundreds of selected examples of animals that illustrate vital points of stock selection. With vast herds of scientifically bred animals at their disposal, the editors and photographers of these unique filmstrips were able to emphasize every significant point of difference between good and poor stock and to hammer home the specific distinguishing characteristics that indicate real quality.

All frames were specially photographed at Oklahoma A. & M. College and at Purdue University, under guidance of Animal Husbandry experts of both institutions and of the United States Department of Agriculture. Photographs were shot by outstanding animal photographers and color technicians to insure absolute accuracy and detailed authenticity.

The three series, SELECTION OF BREEDING STOCK-BEEF, SELECTION OF BREEDING STOCK-SHEEP and SELECTION OF BREEDING STOCK-SWINE are each priced at $12.00, complete with two strips and fully illustrated Teaching Guide. Orders may be placed or information obtained at your local Audio-Visual Division or at Popular Science.

THE SPONTANEOUS REMARKS OF CHILDREN CONCERNING MAGNETIC PHENOMENA

ALFRED A. SILANO
Rutgers University, New Brunswick, New Jersey

An attempt to teach science to elementary school children, by utilizing particular concepts in a formalized drawing procedure, was described in a previous article.[1] The author realized from the data of this experiment that to have future success with this type of learning aid he must get to the core of science concept development in young children. To do this the author decided to investigate further the science information already possessed by children in a particular phase of science, that phase being magnetic phenomena.

A means of gaining an insight into the processes involved in children's thought is actually to observe groups of children in the act of experimenting with scientific principles and apparatus and to record verbatim all pertinent discussion among the children. By using this method, without the contributory influence of adult instruction, the results would be of greater practical value.[2]

PROCEDURE

The data were collected from two groups of pupils, *viz.*, a first grade class[3] and a third grade class,[4] provided by Mrs. Lillian Dare, principal of the Academy Street School, Glassboro, New Jersey. Each group was observed separately, in different classrooms, under similar conditions.

The teacher explained to the groups that he had some objects (magnets) for them to examine. These objects were not called by any particular name so as not to influence the anticipated free verbal expression by the children. The magnets were then distributed with strips of metal. The children were permitted to experiment with their materials and with the materials of their neighbors. Length of time allotted for pupil activity was determined by the observed interest.

A period of free discussion[5] followed the collection of the magnets. Each child was asked to express orally what he thought was responsible for the observed actions of the magnets. No questions or suggestions were contributed to the discussion by the teacher. The conversation followed the direction chosen by the children. The spon-

[1] Alfred A. Silano, "The Drawing as a Learning Aid in Science," 34: 51–55, *Science Education*, February, 1950.
[2] Susan Isaacs, *Intellectual Growth in Young Children*, p. 11.
[3] Mrs. Velma Cassadey, instructor.
[4] Mrs. Gloria Lisa, instructor.
[5] This method of obtaining data has been used frequently by Dr. George W. Haupt of Glassboro State Teachers College.

taneous[6] remarks were recorded verbatim.

Categorical Classification of Remarks

First Grade Group	IQ Range (not tested)
A. Results of bringing a magnet near a metallic object.	
Response	*Frequency*
1. My magnet stuck on my belt buckle.	3
2. I tried it on my suspender catch and it stuck on.	1
3. I put it in my pocket and it jumped out when I put a piece of metal in my pocket.	1
4. It stuck on the radiator.	1
5. The magnet jumped up and caught the metal.	1
6. I put my magnet near Sue's magnet and it jumped up.	2
7. I tried it on my desk and the magnet opened the drawer.	1
8. I tried it on my crayon case and it opened up.	1
B. Results of bringing magnet near a non-metallic object.	
Response	*Frequency*
1. I put it on my arm and it didn't stay.	3
2. I put it on a piece of paper and it wouldn't stay.	1
3. I put it in my hair and it wouldn't stay.	3
4. I tried it on my button and it wouldn't stay.	2
5. I tried it on my dress and it did not stay on.	3
6. I tried it on the table and it wouldn't stick on.	2
7. It sticks through paper.	1
C. Why won't the magnet stick to all objects?	
Response	*Frequency*
1. I guess it can only stick to metal.	3
2. Some metals can stick and some don't.	2
3. I think it don't have gravity.	1
D. Why did the magnet stick?	
Response	*Frequency*
1. The magnet stuck on my belt because it is metal.	5
2. When two (magnets) stick, they both have gravity.	1
Third Grade Group	IQ Range (97–137)
A. Results of bringing a magnet near a metallic object.	
Response	*Frequency*
1. The magnet sticks to the piece of tin.	1
2. I put it on my bobby pin and it almost took it.	3
3. It held the scissors.	1
4. I pulled my magnet away from the tin and the tin chased it.	1
5. It stuck on my belt but not so tight because my belt had too many bumps on it.	1
6. I took this watch my grandfather gave me and it stuck to the main spring.	1
7. I made circles with the magnet and the metal circles, too!	1

[6] A spontaneous remark is interpreted in this study as being a remark due to previous original reflection by the child.

B. Will the magnet attract things through paper or cloth?

Response	*Frequency*
1. The magnet pulled the thing right through the paper.	4
2. It went right through my bookcover.	2
3. It picked the metal right through my dress.	1
4. It wouldn't pull on one side of my desk.	1

C. Why did the magnet stick?

Response	*Frequency*
1. There is something sticky on it and it picked up other things.	1
2. There is some kind of stuff on the magnet that draws it (the strip) up.	1
3. It seemed so sticky, but glue wasn't on the end.	1
4. There seems to be a small gravity on it that makes it stick.	1
5. I think the current does it.	1
6. I think there is electric running through it.	1
7. There must be some electric on the end that makes the tin jump, but we can't call it glue.	1

D. Unclassified Remarks.

Response	*Frequency*
1. My father has a screwdriver home that picks up metal.	1
2. My mother has one (a magnet) to pick up pins when she sews.	1
3. In the Navy Yard they have a great big magnet. That magnet works by electricity.	1
4. I took a little magnet and put it by the metal. I took a big magnet and pulled it away. I guess the bigger magnet is stronger.	1
5. There wasn't enough power in the magnet to make is stick to the brass part.	1
6. I just thought of an experiment. I would take the tin and put it on my hand and see if the magnet would make the tin move right through my hand.	1
7. Maybe if we put it in an oven and heat it, something will happen.	1

Interpretation of the Data

The author realizes that the data of this experiment are incomplete as only two groups of children are considered. The results, however, are similar to the findings of Haupt, *et al.*

The spontaneous remarks made by the first grade children inferred four major categories:

1. Results of bringing a magnet near a metallic object.
2. Results of bringing a magnet near a non-metallic object.
3. Why won't the magnet stick to all objects?
4. Why did the magnet stick?

The third grade children contributed a variation in thought; their remarks were concerned with these categories:

1. Results of bringing a magnet near a metallic object.
2. Will a magnet attract things through paper or cloth?
3. Why did the magnet stick?
4. Unclassified remarks.

It is not difficult to recognize the descriptive and varying nature of the remarks made by the children in the two grades. The younger children were more concerned with the identification of *what* happened while the older children were more concerned with *why* it happened.[7]

Examination of the spontaneous remarks emphasizes the connection between thinking and oral expression by young children. The children were not questioned, but interrogation might have revealed the extent of mastery of the particular concepts expressed.[8] No attempts were made by the teacher to correct any misconceptions of magnetism. Restraint from adult interruption and the encouragement of free expression by the children are important factors to consider, for it is by listening to the young child's verbal expression that the teacher learns what the child is thinking. Teachers cannot appreciate the thinking of their pupils if they constantly interrupt them.[9]

Under the category of unclassified remarks there are suggestions presented by two pupils for the formulation of experiments to discover more facts about magnetism. The suggestion of an experiment to test a speculation is a mature type of thinking on the part of the student, and the teacher should be on the alert to foster growth in this direction.[10] Students also have a tendency to suggest a relation between gravity and magnetism. This is a relationship which scientists have been attempting to establish for the past fifty years, and only recently has there been any mathematical evidence of a connection between magnetic and gravitational phenomena.[11]

Implications for Elementary Science Instruction

The crux of this study is the problem offered to the children—what is causing this metallic object (magnet) to behave as it does? Experimentation with the magnets by the children and their eventual oral expression illustrate the capability of children to discuss a problem.[12]

The children of these groups discovered the effects of magnetic phenomena by direct, individual experimentation, which gave every child a reality of experience. In the early school years science instruction should be largely in the form of direct experience.[13] Giving the

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[7] Katherine E. Hill, *Children's Contributions in Science Discussions*, p. 81.
[8] Jean Piaget, *The Child's Conception of Physical Causality*.
[9] Hill, *op. cit.*, p. 38.
[10] *Ibid.*, p. 52.
[11] Albert Einstein, "Generalized Theory of Gravitation," Appendix II, *The Meaning of Relativity*, pp. 133–147.
[12] Hill, *op. cit.*, p. 26.
[13] Nathan Isaacs, "Education and Science," Appendix B, *Intellectual Growth in Young Children*, pp. 350–354.

children periods of intelligent experimentation will help them in their thinking and understanding of scientific principles.[14] An argument against using this technique is that "it is too expensive." A teacher with a sharp eye for bargains can solve this problem readily. The magnets used in gathering this data were purchased from a manufacturer for less than two dollars. What a small price to pay for having the opportunity of introducing these children to the intriguing study of magnetism!

What did the children learn from this "individualized experimentation"? The children discovered that magnetism passes through some materials, that it can only attract certain metals, that it is related in some way to electricity, and that it is used practicably in industry. It is doubtful whether so many concepts would have been absorbed by just teacher-discussion of magnetism. A significant point is the rapidity with which the children recognized the metallic object as being a magnet. (This is a result of the changing technological structure of the child's environment.)

Another question arises—will the children be interested in this type of pupil activity? The children of this study became so enthusiastic after the exploration period that the teachers had to organize unit plans on magnetism and electricity. At this time the children are studying and constructing simple bell systems, electromagnets, and small electric motors from scrap materials.

Every elementary school science teacher should perform a similar study in his classroom. It is a simple matter to record the remarks of children and from these remarks to prepare units of instruction. The teacher will then be assured that his teaching will begin from the knowledge the pupils already possess.[15] Studies of this nature never cease to be of value as they bring forth the misconceptions of the physical world held by many young children. A teacher can organize his science units for the purpose of teaching understanding and thereby help to eliminate fear and superstition among his pupils.

It is a pleasure to acknowledge suggestions arising in correspondence with Professor George W. Haupt of Glassboro State Teachers College.

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[14] Sidney L. Pressey and Francis P. Robinson, *Psychology and the New Education*, p. 617.

[15] W. Wolff, *The Personality of the Pre-School Child*, p. 295.

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FIND 3,000-YEAR-OLD FLOOD CONTROL AND IRRIGATION WORKS

Ancient Arabia, a thousand years before the birth of Christ, had flood control and irrigation devices far superior to anything they have in that region today. This is among the finds of the American Foundation Arabian Expedition described to the American Philosophical Society here today.

Because of the excess of mud, the ancient people of Qataban did not use storage dams, Dr. W. F. Albright of Johns Hopkins University reported. Their water came in raging torrents in the monsoons. It was caught and turned aside by deflector dams into canals. Weirs and sluices then directed the water onto the land for irrigation. Wherever there was a weir, there was a dike of stone which was a fine piece of engineering, Dr. Albright said.

One extremely important achievement of the expedition, Dr. Albright said, was the successful working out of dates for the finds. Study of several thousand inscriptions made it possible for archaeological "handwriting experts" to develop a system for dating an inscription by the way the letters were formed. The beginning of inscriptions at Qataban occurred 1,000 years before Christ. The first settlement was 1,500 B.C.

Letters in the Southern Arabian alphabet were arranged in nearly the same order that the Abyssinian and Ethiopic alphabet used 1,500 years later. It is different from the alphabet we use, however.

A single mound was excavated clear down to the bottom of bedrock. The pottery of each layer was laid aside and studied separately. The trip down through 50 feet of depth of the mound carried the archaeologists backward in time to 1,000 years before Christ. By arranging samples of each pottery layer in order they were able to construct a pottery calendar by which other finds in the area can be dated over a period of 2,000 years or more of time.

Evidence was found for the earliest foreign commerce of the region, dating back to six centuries before Christ. The people exchanged goods at first with Egypt and Babylonia and later with Greece and Rome.

DEMONSTRATION OSCILLOSCOPE FROM T.V. SET

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Boston University, Boston, Mass.

In view of the high price of commercial large screen oscilloscopes, it was decided at Boston University College of General Education to convert a home T.V. set and still retain the T.V. functions. The set chosen was a 16 inch Phillmore table model with a large enough wooden cabinet to contain the auxillary chassis.

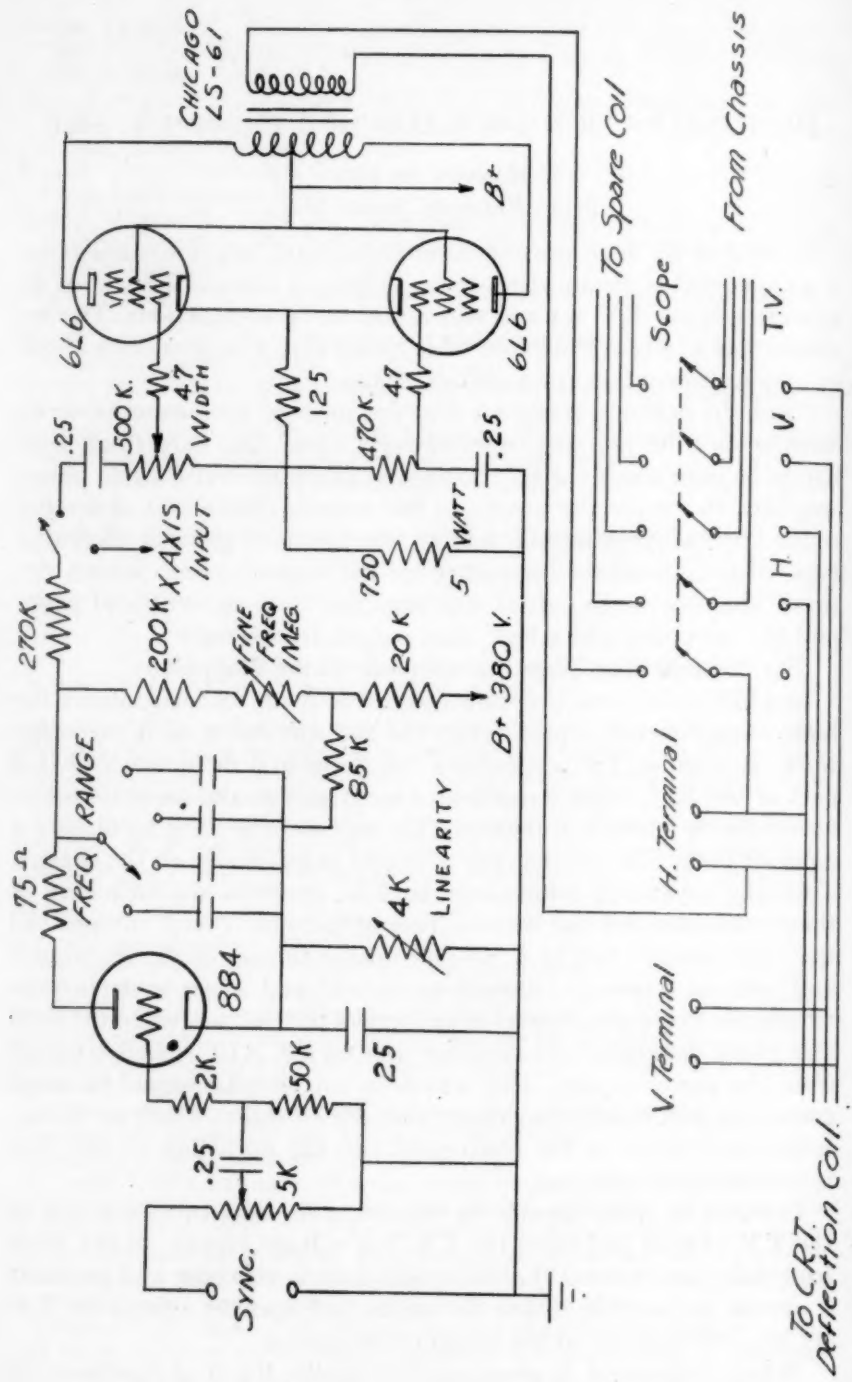
Since the ordinary home set contains most of the elements of an oscilloscope, the job was comparatively easy. The only thing that had to be built was a variable horizontal sweep generator and a power amplifier to couple the sweep to the existing horizontal deflection coils. The sweep generator was of the standard gaseous discharge type with appropriate capacitors for the various sweep speeds desired. This saw tooth output was amplified by a conventional push-pull 6L6 amplifier and a high class output transformer.

(See the following page for complete wiring diagram.)

In addition to these, provisions had to be made for maintaining the high-voltage power supply while the set was being used for scope work. In regular T.V. coperation the horizontal deflection coil is a part of the high voltage oscillator circuit and at the same time furnishes the required T.V. sweep. This was accomplished by buying a separate deflection coil that was mounted permanently on the chassis. Thus the conversion from scope to T.V. involved the switching of these two coils and the introduction of the new sweep voltage. All this was accomplished by a five-pole double-throw switch. Horizontal and vertical terminals, conversion switch, and scope controls were all mounted on a small panel in the rear of the cabinet, while the variable sweep generator and amplifier were on a $8'' \times 10''$ chassis separate from the power supply. This was done so the units would be small enough to bolt inside the cabinet and out of sight. There are no external indications of the conversion and the operation of the T.V. is not affected in any way.

It would be quite feasible by mounting the new tubes directly on the T.V. chassis and using the T.V. low voltage supply, to get away from using an external chassis as was done in this case and probably it would be possible to use the audio and speaker system of T.V. set in order to listen to the sound of the picture.

Acknowledgement is given to Prof. Hollis Baird of Northeastern University for his technical advice.


CHICAGO 25-61
B+
6L6
6L6
.25
500 K.
47
WIDTH
125
470K
47
.25
270K
X AXIS INPUT
200 K
FINE FREQ MEG
750
5 WATT
20 K
B+ 380 V.
85 K
75 Ω
FREQ
RANGE
884
4K
LINEARITY
2K.
50 K
.25
5K
SYNC.
To Spare Coil
From Chassis
Scope
T.V.
V
H
H. Terminal
V. Terminal
To C.R.T. Deflection Coil

ORGANIZING CURRENT MATERIALS FOR EFFECTIVE USE

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Fallston, Maryland

THE PROBLEM

Because of the great wealth of current educational materials available today, every teacher is faced with the problem of developing some system of organization and storage so as to make the best use of them. Only rarely does material appear at just the right time for use in the classroom, and the human memory cannot be depended upon to keep in mind the exact title and location of a piece of material once it has been filed away.

Some written reminder is therefore necessary, but the usual library system, employing title, author, subject, and cross-reference cards, is too cumbersome and time-consuming for a busy school teacher to use. To be effective, a system of organization must be not only economical in its demands upon the teacher's time, but also simple enough so that children can help to operate it. It should include references to all kinds of teaching materials, and each individual item should be fully exploited in all its various applications. The purpose of this paper is to describe a system which seems in large measure to meet these criteria. It has been used successfully by the writer for over three years and included both science and social studies materials.

RESOURCE FOLDERS

The heart of this system of organization is a series of manila folders kept in a vertical file, one folder for each of the major topics or study units ordinarily undertaken in the course being taught. For a physics course these might include such units as: heat, light, sound, electricity and magnetism, fluids, gases, and atomic energy. Inside each "resource folder" are lists of materials which would be useful in teaching that unit or topic. There would be separate lists for books, pamphlets, magazine articles, films, charts, recordings, etc. Whenever the teacher is planning to undertake a certain study unit, these lists are used either to gather together all usable related teaching materials, or to locate those items whose titles had been forgotten.

PAMPHLETS

Figure 1 shows a portion of the pamphlet list from a resource folder on Electricity and Magnetism. Note that the word "pamphlets" is placed at the right margin, so as to be easily visible without

removing the folder all the way from the file. Only the titles of the

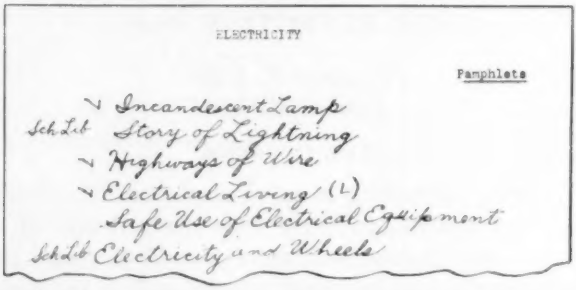

FIG. 1. A Pamphlet List from a Resource Folder on Electricity and Magnetism.

pamphlets are recorded, with a check mark in the left margin to indictae those titles which are in the teacher's classroom collection. Titles to be found in the school library are indicated by an abbreviation such as *Sch Lib*, and in a similar manner materials located elsewhere in the vicinity might be indicated. The pamphlets in the classroom are kept in alphabetical order by title, with a separate section of the file or shelf for each of the two common sizes. The letter (L) after a title indicates that it is in the section with the larger size.

Since it is not likely that a teacher would have immediate access to all the good pamphlets on any subject, some provision is desirable so as to include additional materials, not close at hand, which have received favorable reviews in professional magazines, or which have been recommended by other teachers. A card file is made of these recommended materials, and the titles are jotted down in appropriate resource folders. For these, no location symbol can be placed before the title. Whenever desired, they can be ordered using the information on the card, and then incorporated into the system in the usual way. An easy way to prepare these reference cards is to clip out the magazine review and glue it to a 4 by 6 inch card.

CROSS-REFERENCES

To exploit all the potential uses of any item, and provide necessary cross-references, each pamphlet title is recorded in all the resource folders where it would seem to apply. For example, the General Electric Company's pamphlet entitled "The Story of Steinmetz" could be used with several different study units. It therefore would be noted, not only in the resource folder on electricity, but also in those which were concerned with the history of science and famous men of science. Since many science teachers also have some mathematics courses to teach, this title might also be listed in a resource

folder devoted to this subject. The same procedure would be followed with titles described on the file cards, and thus cross-referencing would be accomplished with only the amount of effort involved in writing down the title in several resource folders. Figure 2 shows by means of a diagram how a pamphlet can be related to several topics by the use of resource folders.

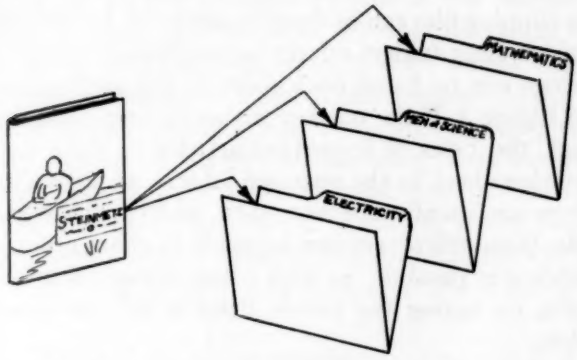

FIG. 2. Cross-Referencing Is Accomplished by Listing a Title in Several Resource Folders.

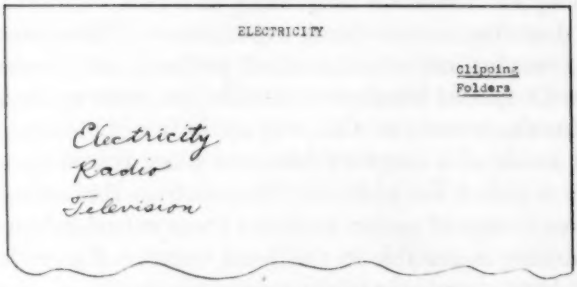

FIG. 3. A Clipping Folder List.

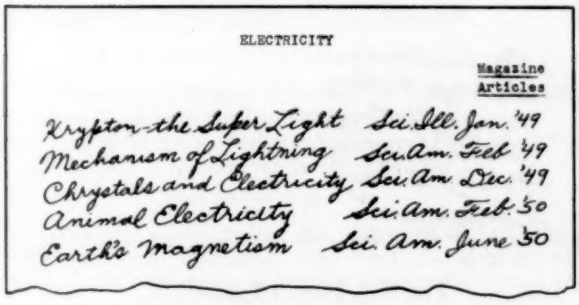
ELECTRICITY
Magazine Articles
Krypton-the Super Light Sci. Ill. Jan. '49
Mechanism of Lightning Sci. Am. Feb. '49
Chrystals and Electricity Sci. Am. Dec. '49
Animal Electricity Sci. Am. Feb. '50
Earth's Magnetism Sci. Am. June '50

FIG. 4. A Magazine Article List.

Magazine Articles

Magazine and newspaper articles are another valuable source of current teaching materials. Since most periodicals are discarded after being read, clipping the more important articles and placing them in vertical file folders is one of the easiest ways to make these materials available for classroom use. If the teacher will jot down on the clipping the heading under which it should be filed, the actual maintenance of the clipping files can be done by students. In case the material from several clipping folders relates to one certain study unit, these folder headings can be listed on a sheet in the appropriate resource folder, as in Figure 3. If the teacher wishes to keep certain magazines on file intact, the titles of important articles in these issues can be listed on another sheet in the resource folders, as shown in Figure 4. Page numbers are usually not necessary, and by abbreviating many of the words, these references can be made in short order. Of course, cross referencing is possible, as with other materials in the resource folder system, by noting the article titles in all the appropriate resource folders.

Projects

A kind of magazine article which deserves special mention is the type which appears in such magazines as *Popular Science Monthly*, and which describes simple home experiments. These provide excellent suggestions for individual student projects and demonstrations, and thus merit special treatment in order to preserve them and prepare them for classroom use. One way to do this is to staple each clipping to the inside of a manila folder and place it in a special section of the vertical file. A list of these "Projects" in the various resource folders makes it easy to gather together these valuable teaching tools. Cross-referencing is possible in the usual manner. Figure 5 shows the projects list from a rseource folder on electricity.

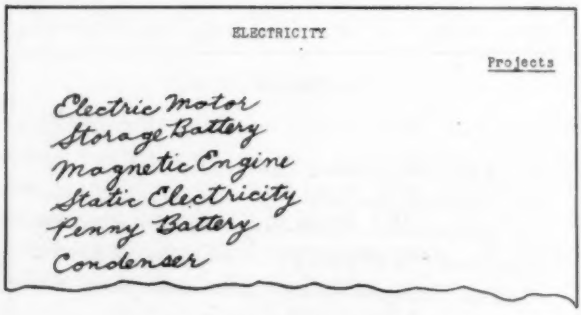

Fig. 5. A Project Folder List.

Other Materials

Having seen how it is possible to organize pamphlet and periodical materials for easy access, it requires no great imagination to discover how the system can be expanded to include all other types of teaching aid. Books, charts, films, and recordings can all be handled in essentially the same manner. Those within easy reach in the classroom or school building can simply be listed by title in the resource folders, with symbols indicating their location. All other references are placed on file cards, along with information as to cost, source, content, and origin of the recommendation. Indeed, the resource folders need not be limited just to lists of materials. They provide very convenient places to keep sample copies of examinations, ideas for good classroom activities, notes on the kinds of questions children frequently ask concerning the topic, and so on. Thus, in time, these manila folders become true *resource* folders, bringing together in one place all kinds of hints, suggestions, and reminders for making a worthwhile study.

Conclusions

Equipped with a set of resource folders, a vertical file containing clippings, projects, and other materials, and a card file with suggestions for additional material, any teacher would seem to be in a good position to make effective use of the great array of teaching materials available today. The resource folder system has proved to be economical of teacher time and simple enough for children to help keep it in operation. All kinds of teaching materials and ideas are listed together in one place, and the various potentialities of each piece of material are fully exploited. In addition, the looseleaf folder has great flexibility, and by its very nature encourages constant and continuous revision. Thus it is much less likely to get out-of-date than more formal printed bulletins. With a resource folder system, a teacher can, with a minimum amount of time and effort, avail himself of a great wealth of teaching materials which can facilitate his teaching and enrich the learning experiences of his students.

FOR FURTHER REFERENCE

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———, "Getting the Most from Business-Sponsored Pamphlets." *The Science Teacher,* Vol. XVII, No. 5 (December, 1950), pp. 228–229.

Electric wrist watch uses a tiny storage cell which can drive a miniature motor over a year before going bad. Because of the even power delivery to the motor, the watch is said to keep time more accurately than conventional spring-wound watches.

PROBLEM DEPARTMENT

CONDUCTED BY G. H. JAMISON
State Teachers College, Kirksville, Missouri

This department aims to provide problems of varying degrees of difficulty which will interest anyone engaged in the study of mathematics.

All readers are invited to propose problems and to solve problems here proposed. Drawings to illustrate the problems should be well done in India ink. Problems and solutions will be credited to their authors. Each solution or proposed problem sent to the Editor should have the author's name introducing the problem or solution *as on the following pages.*

The editor of the Department desires to serve his readers by making it interesting and helpful to them. Address suggestions and problems to G. H. Jamison, State Teachers College, Kirksville, Missouri.

SOLUTIONS AND PROBLEMS

Note. Persons sending in solutions and submitting problems for solutions should observe the following instructions.

1. Drawings in India ink should be on a separate page from the solution.

2. Give the solution to the problem which you propose if you have one and also the source and any known references to it.

3. In general when several solutions are correct, the one submitted in the best form will be used.

Late Solutions

2289, 91. *Sister Angela Mary, Cleveland.*

2287, 9. *Charles McCracken, Jr., Batavia, Ohio.*

2277. *Clauson Deal, Romulus, N. Y.*

2291. *Joseph M. Synnerdahl.*

2293. *Proposed by V. C. Bailey, Evansville, Indiana.*

Three circles whose radii are a, b, c touch each other externally. Prove that the lengths of the radii of the two circles which touch the three circles are

$$abc/[(ab+bc+ca)\pm 2\sqrt{abc(a+b+c)}].$$

Solution by C. W. Trigg, Los Angeles City College

In any triangle with sides d, e, f the distances m, n, p of a point P in the plane of the triangle from the vertices may be shown with the aid of the law of cosines to be connected by the relationship:

$$d^2(m^2-n^2)(m^2-p^2)+e^2(n^2-p^2)(n^2-m^2)+f^2(p^2-n^2)(p^2-m^2)+d^2m^2(d^2-e^2-f^2)$$
$$+e^2n^2(e^2-f^2-d^2)+f^2p^2(f^2-d^2-e^2)+d^2e^2f^2=0. \quad (1)$$

In the case of this problem $d=a+b$, $e=b+c$, $f=c+a$, $m=r\pm c$, $n=r\pm a$, $p=r\pm b$, where the $+$ or $-$ sign is used according as r is the radius of the internally or of the externally tangent circle. When these values are substituted in (1) and the expression is simplified we have

$$[(ab+bc+ca)^2-4abc(a+b+c)]r^2-2abc(ab+bc+ca)r+a^2b^2c^2=0. \quad (2)$$

Therefore,

$$r=abc/[(ab+bc+ca)\pm 2\sqrt{abc(a+b+c)}].$$

2293. *Proposed by Walter H. Carnahan, Lafayette, Indiana*

A plane of unlimited extent is covered by a checker board pattern of 1.5″ squares. If a penny (diameter .75″) is dropped at random, what is the probability that the penny will overlap a vertex?

Solution by V. C. Bailey, Evansville College, Evansville, Ind.

If a penny is to overlap a vertex, its center must be within $\frac{3}{8}$ inch of a vertex. Within each square the area on which a penny center must fall in order to overlap a vertex is

$$4\left[\frac{\pi(3/8)^2}{4}\right]=\frac{9\pi}{64}\text{ sq. in.}$$

Therefore the probability that the penny will overlap a vertex is

$$p=\frac{\frac{9\pi}{64}}{(1.5)^2}=\frac{\pi}{16}.$$

Solutions were also offered by: Richard H. Bates, Milford, N. Y.; C. W. Trigg, Los Angeles City College; Charles McCracken, Jr., Batavia, Ohio; Leon Bankoff; Los Angeles.

2294. *Proposed by Charles McCracken, Cincinnati, Ohio.*

If the arc of a circle is 20 and the chord is 16, find the radius.

Solution by R. L. Moenter, Midland College, Fremont, Nebraska

From well known formulas we have:

$$r\theta=20 \tag{1}$$

$$2r\sin\frac{\theta}{2}=16 \tag{2}$$

where r is the radius of the circle and θ is the size of the central angle in radians.

Eliminating r from (1) and (2) we have:

$$5\sin\frac{\theta}{2}-2\theta=0. \tag{3}$$

By Newton's Method we find $\theta/2=1.1311$ correct to four decimal places.

By substitution we find $r=8.841$.

Solutions were also offered by: Margaret Willerding, St. Louis; W. E. Saul; J. H. Braun, Washington; Glenn M. Eddington, Greeneville, Tenn.; Hugo Brandt, Chicago; and the proposer.

2295. *Proposed by C. W. Trigg, Los Angeles City College.*

$D-ABC$ is a regular tetrahedron, and P is any point on the surface of the inscribed sphere. Show that $(PA)^2+(PB)^2+(PC)^2+(PD)^2$ is a constant.

Solution by the Proposer

Let the inradius of $D-ABC$ be r, the edge $s=2r\sqrt{6}$ and D be the vertex closest to P. The foot of the altitude DD', which passes through the incenter I, is the centroid of the face ABC. Also $DI:ID'::3:1$.

Now the square of the median issued from a given vertex of a tetrahedron is equal to the arithmetic mean of the squares of the three edges issued from the same vertex diminished by one-ninth of the sum of the squares of the remaining edges. [Altshiller-Court, *Modern Pure Solid Geometry*, (1935), page 57.] Hence in the tetrahedron $P-ABC$,

$$3(PD')^2=(PA)^2+(PB)^2+(PC)^2-s^2.$$

Applying Stewart's Theorem to triangle $PD'D$, we have

$$(PD)^2=16r^2-3(PD')^2.$$

Therefore,

$$(PA)^2+(PB)^2+(PC)^2+(PD)^2=16r^2+s^2=40r^2=4(r^2+R^2),$$

where R is the circumradius.

Solutions were also offered by: Hugo Brandt, Chicago; Richard H. Bates Milford, N. Y.; Leon Bankoff, Los Angeles; J. H. Braun, Washington.

2296. *Proposed by Hugo Brandt, Chicago, Ill.*

If the area of a spherical regular quadrilateral with all angles equal and all sides equal to 1 degree, is called a "square degree," how many "square degrees" are contained in area of the surface of the sphere?

Solution by the proposer

Let $ABCD$ be the quadrilateral described and draw the diagonals AC and BD to intersect in M. Then the right triangle ABM has $\measuredangle BMA=90°$, side $AB=1°$, and $\measuredangle MAB=\measuredangle MBA=x$. Applying Napier's formula to this triangle, we have

$$\cos 1°=\cot^2 x, \qquad \cot x=\sqrt{\cos 1°}.$$

By use of 7-place table of logarithms, we find $x=45°\ 7.85'$.

The spherical excess of $\triangle ABM$ is $e=2x-90°$, its area $e/720°$. The area of $ABCD$ is $4e$. The area of the sphere is $720°$. Hence the number of square degrees in the total area is

$$\frac{720}{4e}=\frac{90°}{x-45°}=\frac{90°}{7.85'}=41{,}274.$$

Solutions were also offered by: Charles W. Trigg, Los Angeles City College and Julian H. Braun, Washington, D. C.

EDITOR'S NOTE. Problem 2235 had only one solution, which was never present. A request for its solution was made. So ever though it is late the following solution is offered.

2297. *Proposed by Cecil B. Reed, Wichita, Kansas.*

Prove that

$$8(\sin \pi/7)(\sin 2\pi/7)(\sin 3\pi/7)=\sqrt{7}.$$

Solution by Julian H. Braun, Washington, D. C.

The roots of $x^7-1=0$ are

$$x=\cos\frac{2k\pi}{7}+i\ \sin\frac{2k\pi}{7}, \qquad k=0,\ \pm1,\ \pm2,\ \pm3$$

$$\therefore\ x^7-1=(x-1)\prod_{k=1}^{3}\left(x-\cos\frac{2k\pi}{7}-i\sin\frac{2k\pi}{7}\right)\prod_{k=1}^{3}\left(x-\cos\frac{2k\pi}{7}+i\sin\frac{2k\pi}{7}\right)$$

whence

$$\frac{x^7-1}{x-1}=\prod_{k=1}^{3}\left(x^2-2x\ \cos\frac{2k\pi}{7}+1\right).$$

Let x approach 1.

Now

$$\lim_{x\to1}\frac{x^7-1}{x-1}=7.$$

Therefore

$$7=\prod_{k=1}^{3}\left(2-2\cos\frac{2k\pi}{7}\right)$$

$$=64\left(\frac{1-\cos\frac{2\pi}{7}}{2}\right)\left(\frac{1-\cos\frac{4\pi}{7}}{2}\right)\left(\frac{1-\cos\frac{6\pi}{7}}{2}\right)$$

$$=64\sin^2\left(\frac{\pi}{7}\right)\sin^2\left(\frac{2\pi}{7}\right)\sin^2\left(\frac{4\pi}{7}\right)$$

whence

$$\sqrt{7}=8\sin\frac{\pi}{7}\sin\frac{2\pi}{7}\sin\frac{3\pi}{7}.$$

Solutions were also offered by: Leon Bankoff, Los Angeles; C. W. Trigg, Los Angeles City College; Charles Salkind, Brooklyn; Hugo Brandt, Chicago; Richard H. Bates, Milford, N. Y.; James F. Gray, Kirkwood, Mo.; R. L. Moenter, Fremont, Neb.

2298. *Proposed by Norman Anning.*

The sides of a possible triangle are in arithmetical progression. Show that, with one trivial exception, the intermediate angle is less than 60°.

First Solution by Aaron Buchman, Buffalo, New York

In triangle ABC, let the sides be a, b, c, as usual, and let the intermediate angle be B. Let the common difference of the sides be d.

Then

$$a=b-d \quad \text{and} \quad c=b+d.$$

Now a well known formula in trigonometry is

$$\cos B=\frac{a^2+c^2-b^2}{2ac}.$$

Replacing a and c by their equivalents and simplifying, yields

$$\cos B=\frac{b^2+2d^2}{2(b^2-d^2)}=\frac{K}{2} \quad \text{where} \quad K=\frac{b^2+2d^2}{b^2-d^2}.$$

Now in the trivial case where $d=0$ and $b\neq 0$, then

$$K=1, \quad \cos B=\tfrac{1}{2}, \quad \text{and} \quad B=60°.$$

In all other cases where $d\neq 0$ and $b\neq 0$, it follows that

$$K>1, \quad \cos B>\tfrac{1}{2}, \quad \text{and} \quad B<60°.$$

Second Solution by James F. Gray, Kirkwood, Mo.

Let the sides of the triangle be a, $a+d$, $a+2d$, and the opposite angles, respectively, α, β, and $\gamma=180-(\alpha+\beta)$.

Then

$$\frac{a}{\sin\alpha}=\frac{a+d}{\sin\beta}=\frac{a+2d}{\sin(\alpha+\beta)}.$$

By Law of Addition for proportions

$$\frac{2(a+d)}{\sin\alpha+\sin(\alpha+\beta)}=\frac{a+d}{\sin\beta}$$

and

$$2\sin\beta=\sin\alpha+\sin(\alpha+\beta).$$

Hence,

$$4 \sin \frac{\beta}{2} \cos \frac{\beta}{2} = 2 \sin \left(\frac{2\alpha+\beta}{2}\right) \cos \left(-\frac{\beta}{2}\right)$$

and

$$\sin \frac{\beta}{2} = \frac{1}{2} \sin \left(\frac{2\alpha+\beta}{2}\right) \leqq \frac{1}{2} \tag{1}$$

$$\therefore \quad \frac{\beta}{2} \leqq 30^\circ$$

$$\beta \leqq 60^\circ.$$

If $\beta = 60^\circ$, (1) yields $\alpha = 60$, and we have the trivial case of the equilateral triangle.

Solutions were also offered by: Hugo Brandt, Chicago; R. L. Moenter, Fremont, Neb.; C. W. Trigg, Los Angeles City College; Leon Bankoff, Los Angeles; Richard H. Bates, Milford, N. Y.; Charles Salkind, Brooklyn.

HIGH SCHOOL HONOR ROLL

The Editor will be very happy to make special mention of high school classes, clubs, or individual students who offer solutions to problems submitted in this department. Teachers are urged to report to the Editor such solutions.

Editor's Note: For a time each high school contributor will receive a copy of the magazine in which the student's name appears.

2288. *N. Patellis, Toronto.*

2287. *W. M. H. Grover, Toronto, Martin Schmooklev, Brooklyn.*

2289, 92. *W. M. H. Grover, S. P. Godwin, L. Mintzberg, Toronto.*

2235. *Proposed by Max Beberman, Shanks Village, N. Y.*

Given a semi-circular area of radius r and a rod of length $s < 2r$. Let P be a point on the rod dividing s into two lengths in the ratio $m:n$. If the rod is free to move in the semicircular area, find the area of the region in which P will always be found.

Solution by C. W. Trigg, Los Angeles City College

Case I. $r < s < 2r$. As the line $AB = s$ slides around the semicircle, P will generate the arc PP' of a circle with radius $OP = R$. Now if $AP:PB :: m:n$, as AB swings around A, P will generate an arc PE. As BA swings about B', P will generate an arc $P'E'$. Hence, P will always be found in or on the boundary of the region bounded by the arcs PE, PP', $P'E'$ and the line segment EE'.

In the triangle AOB, by Stewart's Theorem,

$$sR^2 = [ms/(m+n)]r^2 + [ns/(m+n)]r^2 - [ms/(m+n)][ns/(m+n)]s,$$

so

$$R^2 = r^2 - mns^2/(m+n)^2.$$

$$\sphericalangle BAB' = \sphericalangle A'B'A = \phi = \arccos s/2r = \arcsin \sqrt{4r^2 - s^2}/2r.$$

In triangle APO,

$$\sin AOP/\sin \phi = [ms/(m+n)]/R.$$

$$\sphericalangle AOP = \theta_1 = \arcsin ms\sqrt{4r^2 - s^2}/2rR(m+n).$$

$$\sphericalangle B'OP' = \theta_2 = \arcsin ns\sqrt{4r^2 - s^2}/2rR(m+n).$$

The half-lune

$$CPE = \text{sector } APE + \text{sector } OCP - \text{triangle } APO$$
$$= (\phi/2\pi)\pi m^2 s^2/(m+n)^2 + (\theta_1/2\pi)\pi R^2 - \tfrac{1}{2}[ms/(m+n)]r\cdot\sqrt{4r^2-s^2}/2r.$$
$$= \tfrac{1}{2}\{\phi m^2 s^2/(m+n)^2 + \theta_1 R^2 - ms\sqrt{4r^2-s^2}/2(m+n)\}.$$

The half-lune

$$DP'E' = \text{sector } B'P'E' + \text{sector } ODP' - \text{triangle } OP'B'$$
$$= \tfrac{1}{2}\{\phi n^2 s^2/(m+n)^2 + \theta_2 R^2 - ns\sqrt{4r^2-s^2}/2(m+n)\}.$$

Area

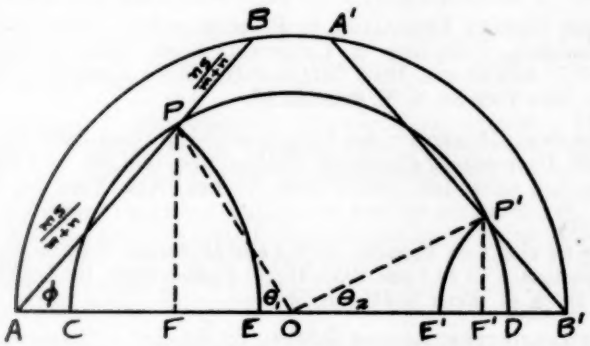
$$EPP'E' = \text{semicircle } CPP'D - \text{half-lune } CPE - \text{half-lune } DP'E'$$
$$= \tfrac{1}{2}[(\pi-\theta_1-\theta_2)R^2 - \phi(m^2+n^2)s^2/(m+n)^2 + s\sqrt{4r^2-s^2}/2],$$

where θ_1, θ_2, ϕ and R have the values given above.

Case II. $0 < s \leqq r$, $m \geqq n$. In this case, the rod is free to rotate inside the semicircle, so the area in which P will be found is

$$\tfrac{1}{2}\pi R^2 - \phi n^2 s^2/(m+n)^2 - \theta_2 R^2 + ns\sqrt{4r^2-s^2}/2(m+n).$$

In the spacial case, $m=n$, $r=s$, the area $EPP'E'$ is $r(2\pi+3\sqrt{3})/12$.



PROBLEMS FOR SOLUTION

2311. *Proposed by J. C. Williams, Chicago.*

A candy dish contains 25 vanilla creams, 10 maple creams and 10 raspberry creams. What is the least number one must take out of the bowl to be sure of having

a) two with same flavor
b) two with different flavors
c) three with different flavors
d) three with same flavor

2312. *Proposed by Hugo Brandt, Chicago.*

For the ellipse $x^2+7y^2-7=0$ find points on line $x=y$, such that of the two tangents from them, one is twice as long as the other.

2313. *Proposed by Cecil B. Read, Wichita, Kansas.*

If $x+y=4$, with all values of x between 0 and 2 equally probable, show that the probability that xy exceeds 3 is $\frac{1}{2}$.

2314. *Proposed by Wm. Giddings, Savannah, N. Y.*

In right triangle ABC, c being the hypotenuse, r radius of incircle, if $a-b=1$,

$r=1$ and altitude on AB is 12/5, find the sides of the triangle.

2315. *Proposed by Ethel Dildine, Yale, N. Y.*

Solve:

$$x^2+y^2=13$$
$$x^2y+xy^2=30$$

2316. *Proposed by Norman Anning, University of Michigan.*

Two points A and B are distinct. If C is mid point of AB, D of BC, E of CD, F of DE, etc., show that the successive points approach a definite limit-point. If L is the name of this limit-point, find ratio of AL to LB.

BOOKS AND PAMPHLETS RECEIVED

CALCULUS, by John F. Randolph, Ph.D., *Professor and Chairman of the Department of Mathematics, University of Rochester.* Cloth. Pages x+483. 15×23.5 cm. 1952. The Macmillan Company, 60 Fifth Avenue, New York 11, N. Y. Price $5.00.

SECONDARY SCIENCE EDUCATION, by Harrington Wells, *Associate Professor of Science Education, University of California, Santa Barbara College.* Cloth, Pages xi+367. 15×23 cm. 1952. McGraw-Hill Book Company, Inc., 330 W. 42nd Street, New York 36, N. Y. Price $4.50.

UNDERSTANDING HEREDITY, AN INTRODUCTION TO GENETICS, by Richard B. Goldschmidt, *University of California.* Cloth. Pages ix+288. 13.5×21 cm. 1952. John Wiley and Sons, Inc., 440 Fourth Avenue, New York 16, N. Y. Price $3.75.

THE RISE OF THE NEW PHYSICS, Vols. I and II, Second Edition, by A. D'Abro. Cloth. 1040 pages. 13×20.5 cm. 1951. Dover Publications, Inc., 1780 Broadway, New York 19, N. Y. Price $8.00 the set.

BRIEF TRIGONOMETRY, Revised Edition, by Edward A. Cameron, *University of North Carolina.* Cloth. Pages vi+153. 13×19.5 cm. 1952. Henry Holt and Company, 383 Madison Avenue, New York 17, N. Y. Price $2.10.

COLLEGE ALGEBRA, by Ross R. Middlemiss, *Professor of Mathematics, Washington University.* Cloth. Pages xix+344. 15×23 cm. 1952. McGraw-Hill Book Company, Inc., 330 W. 42nd Street, New York 36, N. Y. Price $3.50.

THE ELEMENTS OF MATHEMATICAL ANALYSIS, Vols. I and II, Second Edition, by J. H. Michell, M.A., F.R.S., *Formerly Fellow of Trinity College, Cambridge and Professor of Mathematics, the University of Melbourne;* and M. H. Belz, M.Sc., M.A., *Associate Professor of Mathematical Statistics, the University of Melbourne.* Cloth. 1087 pages. 14×22 cm. 1950. The Macmillan Company, 60 Fifth Avenue, New York 11, N. Y. Price $13.60 the set.

ZOOLOGY IN POSTAGE STAMPS, by W. Dennis Way, Editor, *Stamp Collectors' Fortnightly,* 1941–50, and O. D. Standen, M.Sc., *Fellow of the Zoological Society.* Cloth. Pages vii+113. 17.5×24 cm. 1952. The Philosophical Library, Inc., 15 E. 40th Street, New York 16, N. Y. Price $5.00.

SECOND ALGEBRA, by Virgil S. Mallory, *Professor of Mathematics and Instructor in the College High School, State Teachers College, Montclair, New Jersey;* and Kenneth C. Skeen, *Head of the Department of Mathematics, Union High School and Junior College, Taft, California.* Cloth. Pages vii+480. 13×20.5 cm. 1952. Benj. H. Sanborn and Company, 221 E. 20th Street, Chicago 16, Ill.

DICTIONARY OF MIND, MATTER AND MORALS, by Bertrand Russell. Edited with an Introduction by Lester E. Denonn. Cloth. Pages xiv+290. 14.5×23 cm. 1952. The Philosophical Library, 15 E. 40th Street, New York, N. Y. Price $5.00.

MATHEMATICS: A SECOND COURSE, by Myron F. Rosskopf, *Associate Professor of Mathematics and Education at Syracuse University;* Harold D. Aten, *Oakland California;* and William D. Reeve, *Professor Emeritus of Mathematics, Teachers College, Columbia University.* Cloth. Pages xviii+365. 14×21.5 cm. 1952. McGraw-Hill Book Company, Inc., 330 W. 42nd Street, New York 36, N. Y. Price $2.80.

FUNDAMENTALS OF HEALTH AND SAFETY, Second Edition, by Grover W. Mueller, *Instructor, Teachers College, Temple University,* and Elizabeth Chant Robertson, *Department of Paediatrics, University of Toronto.* Cloth. Pages ix +345. 15×23 cm. 1952. D. van Nostrand Company, Inc., 250 Fourth Avenue, New York 3, N. Y. Price $2.80.

CONTRIBUTIONS TO THE FOUNDING OF THE THEORY OF TRANSFINITE NUMBERS, by Georg Cantor. Translated and Provided with an Introduction and Notes by Philip E. B. Jourdain. Paper. Pages vii+211. 12.5×20.5 cm. Dover Publications, Inc., 1780 Broadway, New York 19, N. Y. Price $1.25.

FREDDY FOX SQUIRREL, by R. W. Eschmeyer, *Executive Vice President of the Sport Fishing Institute.* Cardboard. 49 pages. 12.5×17 cm. 1952. Fisherman Press, Inc., Oxford, Ohio.

BASIC ALGEBRA, A TEXTBOOK IN INTERMEDIATE ALGEBRA, by M. Wiles Keller, *Purdue University.* Paper. Pages xii+290. 20.5×28 cm. 1952. Houghton Mifflin Company, 2 Park Street, Boston, Mass. Price $1.90.

A PHILOSOPHICAL ESSAY ON PROBABILITIES, by Pierre Simon, *Marquis de LaPlace.* Translated from the Sixth French Edition by Frederick Wilson Truscott and Frederick Lincoln Emory with an Introductory Note by E. T. Bell, *Professor, California Institute of Technology.* Paper. Pages viii+196. 12.5×20.5 cm. 1951. Dover Publications, Inc., 2780 Broadway, New York 19, N. Y. Price $1.25.

THE RADIO AMATEUR'S HANDBOOK, by the Headquarters Staff of the American Radio Relay League. Twenty-Ninth Edition. Paper. 784 pages, including Catalog Section and 13-page Topical Index. 16.5×24 cm. 1952. The American Radio Relay League, West Hartford 7, Conn. Price $3.00.

SCHOOL HOUSING FOR PHYSICALLY HANDICAPPED CHILDREN, by Romaine P. Mackie, *Specialist, School for the Physically Handicapped.* Bulletin 1951, No. 17. Pages vi+26. 14.5×23 cm. Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. Price 15 cents.

YOUR OPPORTUNITIES IN SCIENCE, by National Association of Manufacturers. Paper. 30 pages. 15×21.5 cm. 1952. National Association of Manufacturers, 14 W. 49th Street, New York 20, N. Y.

FIRST PROGRESS REPORT OF THE SCHOOL FACILITIES SURVEY, 1951–1952, Prepared by the School Housing Section, Office of Education. Paper. Pages ix+77. 19.5×26 cm. Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. Price 40 cents.

PASTEUR'S STUDY OF FERMENTATION, Edited by James Bryant Conant. Case 6. Paper. 57 pages, 15×23 cm. 1952. Harvard University Press, Cambridge 38, Mass. Price $1.00.

STRENGTH FOR THE LONG RUN. Fifth Quarterly Report to the President, by the Director of Defense Mobilization, Charles E. Wilson. Paper. Pages iv+48.

20×26 cm. Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. Price 35 cents.

AUFGABENSAMMLUNG ZU DEN GEWÖHNLICHEN UND PARTIELLEN DIFFERENTIALGLEICHUNGEN. Von Dr. Guido Hoheisel, *Professor der Mathematik an der Universität Köln.* Paper. 124 pages. 10×15.5 cm. Walter de Gruyter and Company, Berlin w 35.

THE MUTUAL SECURITY PROGRAM FOR A STRONG AND FREE WORLD. First Report to Congress, December 31, 1951, by Harry Truman, The White House. Paper. Pages v+81. 20×26 cm. Office of the Director for Mutual Security, Washington 25, D. C.

IT'S FUN TO KNOW WHY, EXPERIMENTS WITH THINGS AROUND US, by Julius Schwartz, illustrated by Edwin Herron. Cloth. Pages 125. 14×20 cm. 1952. Whittlesey House, McGraw-Hill Book Company, Inc., 330 West 42nd Street, New York 36, N. Y.

EDUCATIONAL DIRECTIONS, A REPORT—1951. Reprinted from the 33rd Edition of The Handbook of Private Schools. F. Porter Sargent, 11 Beacon Street, Boston, Mass. Cloth. Pages 128. 11×18 cm. 1951. Price $2.00.

METEOROLOGY, AN ELEMENTARY TEXTBOOK, by Jas. R. Wilson, *Phoenix Union High School* and R. J. Hannelly, *Dean of Phoenix College.* Paper. Pages iv+92. 21×27 cm. 1951. Printery Publishing Co., Phoenix, Arizona.

BOOK REVIEWS

ELIAS E. RIES, INVENTOR, by Estelle H. Ries. Cloth. Pages xii+369. 13×21.5 cm. 1951. The Philosophical Library, Inc., 15 East 40th Street, New York 16, N. Y. Price $4.75.

Was Elias E. Ries a great inventor, ranking with Thomas Edison, Elihu Thompson, Alexander Graham Bell, George Westinghouse, and Lee DeForest? School boys all over the nation know these five great men and their inventions, but has one of them ever heard of Ries? Here is the story of his life, written by his daughter, probably the only one who could tell the true story. The early part is of course gleaned from others but the later chapters are her own observations, experiences and thought as she lived with her parents and endured some of the hardships and disappointments that came that way. Ries took out over 200 patents on electric elevators, talking pictures, sound signalling, the convertor, electric riveting, etc. But for all these he received practically nothing and died a poor man even though they brought in millions to other men and companies. His wife taught school to provide the necessary household expenses. Much of his experimenting was done right in his home, without shop or sufficient tools. He did his own work without subordinates or assistants, made his own drawings, and wrote up his results. He received no help from foundations or universities.

In one of the last chapters Miss Ries makes some important suggestions to prevent repetition of neglect of genius. She says: "A good deal is heard these days of research laboratories of large corporations. . . . The fact is that the total output of corporation inventors is a small proportion of the whole. Most really valuable inventions are still created by independent minds." Another thought is worth consideration: "The government spends for protection against criminals; why not for something constructive, positive and enriching, for its creative geniuses?" You may not agree with all the author has to say but her words will cause you to think. Possibly before the close of the century all will agree that the words inscribed on his tombstone tell a great truth. These are: INVENTOR PHILOSOPHER SEER.

G. W. W.

INTERMEDIATE ALGEBRA, Second Edition, by Raymond W. Brink, Ph.D., *Professor of Mathematics, University of Minnesota.* Cloth. Pages xi+295. 13.5×21.5 cm. 1951. Appleton-Century-Crofts, Inc., 35 West 32nd Street, New York 1, N. Y. Price $3.00.

COLLEGE ALGEBRA, Second Edition by Raymond W. Brink, Ph.D., *Professor of Mathematics, University of Minnesota.* Cloth. Pages xvi+495. 13.5×21.5 cm. 1951. Appleton-Century-Crofts, Inc., 35 West 32nd Street, New York 1, N. Y. Price $3.75.

The author has taken the first fifteen chapters of his College Algebra (265 pages) and issued this material under the title of Intermediate Algebra. The subject matter is more extensive than can normally be covered in a two or three semester hour course in intermediate algebra. The first chapter is a well written discussion of our real number system. Following this chapter, the material covered includes fundamental operations, fractions, linear equations in one, two, and three unknowns, exponents and radicals, functions and graphs, quadratic equations in one and two unknowns, ratio, variation, progressions, logarithms, and the binomial theorem. This completes the intermediate algebra. The college algebra continues with mathematical induction, inequalities, complex numbers, theory of equations, permutations, combinations, and probability, determinants, infinite series, partial fractions, a simple treatment of mathematics of investment, and a chapter on curve fitting and least squares. The material covered, except for the last two chapters, is somewhat traditional.

The author states that in the second edition all exercises have been changed, in addition to a general revision of the first edition. The success of the first edition speaks well for the text. Some teachers may feel that an intermediate algebra should be something more than the first half of a college algebra text—this is of course a matter of opinion. There is an ample supply of exercises, with answers to half the problems.

The definitions are well phrased, in such a manner that the student will not later need to revise them. Several good features were noted, for example, the illustration on page 63 of a fractional equation which has no solution; the functional notation for functions of more than one variable; the outline of procedure in the chapter on theory of equations.

Since individual opinion has much to do with the choice of a text, the reviewer can only point out that either of these books seems very distinctly above the average, and should by all means receive consideration when a change of text is contemplated.

C. B. READ
University of Wichita

CALCULUS AND ANALYTIC GEOMETRY, by George B. Thomas, Jr., *Associate Professor of Mathematics, Massachusetts Institute of Technology.* Cloth. 693 pages. 15×23 cm. 1951. Addison-Wesley Press, Inc., Kendall Square, Cambridge 42, Mass. Price $6.00.

The first reaction to this book tends to be unfavorable for two reasons: excessive bulk and a typography which seems hard on the eyes. However, the author points out that a complete revision is planned in a couple of years and for this reason, the copy was prepared on an automatic typewriter rather than being set in type. This, of course, accounts in part for the bulk. In addition, there is considerably more material covered in this text than in the traditional first year analytics or calculus text. For example, there is a rather detailed treatment of vectors including vector calculus, an extensive treatment of complex numbers including for example a discussion of the Cauchy-Riemann differential equations. There is a chapter on determinants and linear equations and there is some discussion of line integrals.

In few places, there were points which did not seem quite clearly treated. For example, on page 7, it is not clear which angle β is covered by the formulas.

On page 269, it is not made clear that the tests for symmetry are sufficient, but not necessary conditions. On page 616, in discussing relative maximum and minimum points of a function of two variables, some students will ask what happens if $AC-B^2=0$. These points are, however, in the distinct minority. The book as a whole has many unusual and excellent features, so many in fact that this review cannot mention all of them. A few, however, are, in the opinion of the reviewer, outstanding. The discussion of the epsilon, delta conditions for approaching a limit is put into language which the beginner might well understand without losing any rigor. Particularly interesting is his approach from the point of view of a "tolerance limit" used in manufacturing. One does not always find, in a first-year text, the clear distinction between ordinary continuity and uniform continuity found on pages 82 and 83, again with an unusual method of presentation. The author is careful to point out that all authorities do not agree in the principal values of the inverse secant of x, but he gives reasons for his own choice which seem adequate. There is a very good discussion of the application of partial differentiation as it appears in the method of least squares. In the discussion of infinite series, the author points out a particular series which has been used to compute π to 2,035 decimal places on the Eniac. Likewise, in discussion of numerical errors which are involved in computing the series, the author is clear to point out two types of errors which may occur, a treatment which is not usually found in texts. In the discussion of indeterminate forms, the author's illustration of expressions which all take on the general type infinity, yet behave entirely differently as n approaches infinity is again unusual [$n-n$, $n-n^2$, n^2-n].

By no means does the above listing exhaust some of the excellent points of the text. In many places, one feels that the author is speaking the language of the student rather than dry textbook material. Of course some teachers may object to a presentation such as found on page 352, where the author tries to show why certain procedure is used, and at the end, ends his discussion with the word "Hooray!" Many students on the other hand will approve. Again the student going on to later work will appreciate the text which discusses such topics as the directional derivative and the calculus of variations, even though his particular course may not have had sufficient time to include this material.

Unless one objects to the bulk of material which they may not be able to handle in their particular course, this offers distinct possibilities Even if not adopted as a class text, it would be an excellent book for supplementary reference in any junior college library.

C. B. READ

GENERAL BIOLOGY, by James Watt Mavor, *Ph. D., Professor Emeritus of Biology in Union College.* Cloth. Pages xiii+875. 15×23 cm. Fourth Edition. 1952. The Macmillan Company, New York. Price $5.75.

This is the fourth edition of a widely used high school biology text. It follows the pattern of the third edition, the major exception being the elimination of the chapters building up a background of chemistry. These have been summarized in the appendix. There have also been other portions altered slightly and some new material added.

As in all good biology texts, the scientific method is given great emphasis throughout in an effort to develop in students a pattern of logical thinking. The book is flexibly designed so that a teacher can omit sections or use the book in a variety of sequences. There are six parts to the book: the nature of life, which aims to develop a general foundation for further study of biology; plant life, from the simplest to the most highly developed; lower animals, or invertebrates; anatomy and physiology of the frog and man; development and heredity in plants and animals; a broad view of the organic world and its evolution. The book is well supplied with drawings and photographs as aids to the students. Each chapter has a terminal outline of the contents discussed, a list

of questions, and suggested readings. For a general biology text it would be difficult to find one which is more complete or more carefully prepared than this book.

GEORGE S. FICHTER
Oxford, Ohio

HANDBOOK OF BASIC MICROTECHNIQUE, by Peter Gray Ph.D., D.I.C., *Head, Department of Biological Sciences, University of Pittsburgh.* Cloth. Pages viii+141. 15×23 cm. 1952. The Blakiston Company, New York. Price $3.00.

This is a handbook of procedures to be used as an aid to students and laboratory workers who are faced with the problem of preparing animal or plant material for microscopical examination. For workers in cytology, histology, and pathology, it is a time-saving reminder of methods and techniques. Actually, it is a supplement to a larger volume, Gray's *Microtechnique*, which is now in preparation. *Microtechnique* will be a comprehensive reference of methods used past and present. The handbook is for quick consultation to learn about: materials and equipment; fixation and fixatives; stains and staining; dehydrating and clearing; mounts and mountants; making wholemounts; making smears; making sections; cleaning, labeling, and storing slides. Approximately one third of the book is devoted to specific examples of slide making.

GEORGE S. FICHTER

A HISTORY OF THE THEORIES OF AETHER AND ELECTRICITY—(The Classical Theories)—by Sir Edmund Whittaker F.R.S., *Honorary Fellow of Trinity College, Cambridge.* 434 pages. Index of Authors. Philosophical Library 1951. Price $12.00.

From the preface: "In 1910 I published a work under the title *A History of the Theories of Aether and Electricity, from the Age of Descartes to the close of the nineteenth century.* When the original edition was exhausted, I felt that any new issue should describe the origins of relativity and quantum-theory, and their development since 1900. My opportunities were however not sufficient to enable me to prepare an accurate and fully-documented account of this very creative period, and I was compelled to lay the plan aside. Retirement from my professorial chair has made it possible for me to take up this project again; it will occupy two volumes, of which this, the first, deals with the classical theories. The volume of 1910 has been to a considerable extent rewritten, with the incorporation of much additional material; and in the second volume, the story will be continued to the present time."

This book cannot be "reviewed"! It is enough to say that it is the work of a foremost scholar of this century and the last—a physicist, philosopher, mathematician. Although essentially historical it is philosophy, physics, and mathematics of the first temper. Philosophers interested in the scientific aspects of human knowledge will find here a veritable gold-mine. Physicists will profit immeasurably from this elegant penetrating examination of the classical theories of the aether and electricity. The documentation is astonishing.

Although heavy reading the exposition is delightfully clear. I cannot help but call attention to the style, the language, the words—as an illustration of the beauty that prevails throughout the treatise:

> "Among experimental philosophers Faraday holds by universal consent the foremost place. The memoirs in which his discoveries are enshrined will never cease to be read with admiration and delight; and future generations will preserve with an affection not less enduring the personal records and familiar letters, which recall the memory of his humble and unselfish spirit."

I have said elsewhere that the history of physics (indeed, the history of *anything*), is essentially the story of *men*. The *Index of Authors* bears this idea out. This treatise then, is the recitation of what men have thought and done in the realm of the aether, and takes us into the Age of Lorentz.

With the idea of the "ether" now being revived the volume is deserving of immediate attention. I look forward anxiously to the second volume which must certainly raise some penetrating inquiries.

JULIUS SUMNER MILLER
Dillard University
New Orleans 22, Louisiana

THE DESIGN AND ANALYSIS OF EXPERIMENTS, by Professor Oscar Kempthorne, *Iowa State College (Professor of Statistics)*. 631 pages. John Wiley 1952. $8.50.

This book is designed for three groups of users: the experimenter, who needs to understand the theory and practice of the statistical designs; the consulting statistician, who wants a description of basic theory and methodology of designs; and the mathematical statistician, who is concerned with the validity of the application of statistical techniques to the analysis of data. The techniques are presented in such a way that they can be understood by people with little mathematical training, but the mathematical justification is given for those who are interested.

The place of statistical analysis in modern technology needs no commentary. Indeed, it pervades every aspect of human knowledge. Particularly is it growing in the biological fields. Practically all of our knowledge today is being acquired experimentally, and the design of the experiment and the validity of the data must be closely scrutinized.

Apart from pure statistical theory the book is essentially a course in experimental design for students whose aim is to become consulting statisticians with emphasis towards experimentation.

For workers in the field this volume will rank with the contributions of Fisher and Yates whose works are classical in statistical literature. Along with these should be mentioned, of course, the work of Cochran and Cox entitled Experimental Designs.

For the usefulness of the volume to those engaged in this kind of inquiry the price is not disturbing.

JULIUS SUMNER MILLER

FUNDAMENTALS OF ELECTRONICS, by F. H. Mitchell, *Professor of Physics, University of Alabama*. 242 pages. Addison-Wesley Press 1951. $4.50.

This is one of the Addison-Wesley Physics Series so ably edited by Professor Francis Weston Sears. It is a text designed for a one-semester course, and presumes, but not too seriously, a minimum background in general physics and mathematics (not necessarily through the calculus). The emphasis is on physical reasoning with little attempt at mathematical rigor.

The theme of the book is instrumentation and since much of our technology is now electronic the contents are eminently useful.

The text appears very teachable and I believe a good student could follow it excellently without much instruction. Physics teachers will want to look at it as a foundation course in electronics; others will find the investment worthwhile.

The line diagrams and photographs are excellently done; the format is attractive; the questions and problems are well chosen. I should like to teach the book some time.

JULIUS SUMNER MILLER

FIRST YEAR COLLEGE CHEMISTRY, by John W. Barker, *Wittenberg College* and Paul K. Glascoe, *Carthage College*. Pages ix+501, 15×23 cm. Cloth. 1951. McGraw-Hill Book Company, Incorporated, New York, New York. Price $5.00.

This textbook will be welcomed by those who believe that first year chemistry should include a large section on inorganic chemistry. Atomic theory is intro-

duced in chapter 2 and 3 followed by a discussion of the periodic table in chapter 4. The major portion of the remaining chapters is devoted to a discussion of the families of elements, their properties, compounds, and reactions. Discussion of elementary physical chemistry is kept at a minimum; for example, only 5 pages are allotted to colloid chemistry. There is one chapter on radioactivity, one on organic chemistry, and one on biological chemistry. Questions and problems are inserted in the text with addenda designed for the better student at the end of each chapter. The number of illustrations is small, but are well reproduced.

The book appears to be well written and follows current fashion in using the hydronium ion, discussing atomic radii, and electron donors. The make-up is good with excellent paper and printing. The development is thorough and the chapter on chemical equilibrium is particularly good. This textbook will be fine for a first course for chemistry majors.

LILLIAN H. MEYER
Western Michigan College of Education
Kalamazoo, Michigan

TEXT BOOK OF ORGANIC CHEMISTRY, by George Holmes Richter, *The Rice Institute, Houston, Texas.* Cloth. Pages vii+762. 15×23 cm. Third Edition. John Wiley and Sons, Inc., New York, New York Price $6.75.

In the revision of his textbook of organic chemistry the author has included new material on electronic configuration, tracer isotopes and nuclear structure. Added, also, are theoretical explanations of mechanisms pertaining to resonance in unsaturated systems; pi complex theory of aromatic nuclear reactions; color production; and the biosynthesis of sugars. His text is one of the few to explain double bonds in terms of molecular orbital functions of the sigma and pi bonds.

There is some treatment of vinylation, reduction with metallic hydrides, and many important "name" reactions.

The vasoconstrictive compounds, herbicides, insecticides, antibiotics, hormones, and silicones are some of the newer products discussed briefly in this edition.

The text is divided into four main topics. The first eighteen chapters, a total of 376 pages, are devoted to the aliphatic series. The aromatic series have nine chapters of 196 pages. "Some Natural Products" are found in three chapters within 113 pages, and the heterocyclic series are contained in three chapters of 55 pages. The double column index of 17 pages helps greatly in locating "name" reactions. There is no appendix. Aids for beginning students, such as a reference library, a list of organic radicals, a glossary of terms, and a table of constants of the common organic compounds are lacking.

At the end of each chapter one finds approximately 20 well chosen questions, which are excellent aids in comprehension of the preceding topics. No literature references are given.

Errors of fact and type are few. On page 7 the student may be confused by C^{14} isotope being formed by a C-d-p. nuclear reaction. On page 332 the projected structures of lactic acid could be labelled with reference to structural configurations to avoid confusion later. On page 111 one finds aldehydes regenerating the intense red color of the original dye, a statement not supported in the laboratory.

This text is scholarly and comprehensive. It is a help to the average student and its mastery a test of ability for the better students. Teamed with good instruction it should prove to be a very satisfactory and teachable textbook.

ROBERT J. ELRIDGE
Western Michigan College of Education
Kalamazoo, Michigan

MEANINGFUL MATHEMATICS, A SURVEY COURSE FOR COLLEGE STUDENTS, by H. S. Kaltenborn, Ph.D., *Chairman, Department of Mathematics, Memphis*

State College. Cloth. Pages xiv+397, 14×21 cm. 1951. Prentice-Hall, Inc., New York 11, N. Y. $4.75.

To the reviewer this book is an interesting and exciting innovation among college mathematics texts. Since a certain familiarity with and appreciation of the general nature and significance of mathematics should be part of the cultural background of every well-educated individual, this book has been written to fulfill this need for the non-technical student who has neither the time nor the inclination to pursue the traditional courses. Covering the full range of mathematics from the development of primitive number systems and including chapters on differential and integral calculus, it contains an abundance of material for a year's course meeting from three to four times a week. While on first consideration, the author's statement that "this book is well within the ability of average college students who have had no previous training in geometry and only limited experience with algebra" might seem overly optimistic, upon deliberation it becomes evident that with the assistance of a skilled teacher this claim for it might well be realized.

Some of the chapter headings give only a hint of the wealth and variety of material: The Nature of Mathematics; The Number System; Functions and Graphical Representation; Algebraic Processes; Consumer Mathematics; Geometric Processes; Numerical Trigonometry; Computation with Logarithms; Introduction to Differential Calculus; The Conic Sections; The Nature of Integral Calculus; Analytic Trigonometry. There is significant emphasis upon the unity of mathematics and upon the interdependence of its branches, yet each chapter, in so far as possible, has been developed from the beginning. This treatment permits great flexibility in planning the course, and whole chapters and sections of the book may be omitted without disrupting the student's understanding of the rest.

The make-up of the book is attractive, and there are many excellent illustrations and illustrative exercises. Following each presentation is a list of exercises for the student; these are of both a mechanical nature to assist the student to better understanding through mastery of manipulative processes and of a developmental nature to direct the more able students in further study of the topic. A unique feature of many of these lists of exercises is the inclusion of a number of topics for oral or written reports together with suggested reference material. The history of mathematics is interestingly offered, not as a separate unit, but constantly woven into the presentation of the topics. Among some of the other features of the book are several sections on mathematical recreations, a discussion of non-Euclidean geometry, and a presentation of many of the famous problems of mathematics. The appendix includes a table of natural values of the trigonometric functions, a four place log table, and a table of logarithms of the trigonometric functions.

In addition to its use as a textbook in the college field, this book should be a welcome addition to the library of anyone who enjoys mathematics. It seems to me it could also prove valuable to many teachers at the elementary and secondary level who, long absent from formal instruction in any kind of advanced mathematics course, would like some sort of self-study help in revitalizing old understandings.

JOHN K. VAN DYKE
Oak Park, Illinois

GEOGRAPHY IN THE TWENTIETH CENTURY, A Study of Growth, Fields, Techniques, Aims and Trends, Edited by Griffith Taylor, *Head of the Department of Geography at Toronto University.* Cloth. Pages x+630. 13.3×21.5 cm. 1951. The Philosophical Library, Inc., 15 E. 40th Street, New York 16, N. Y. Price $8.75.

One would search long and far for the materials contained in this volume. The 26 chapters have been contributed by 20 geographers of note—American, British and European. They deal with diverse topics representing fields of special re-

search. Together they present modern geography in terms of achievement in many types of investigation and study.

VILLA B. SMITH
John Hay High School
Cleveland, Ohio

GEOGRAPHY OF THE PACIFIC, by Otis W. Freeman, *Editor, Eastern Washington College of Education, Cheney, Washington.* Cloth. Pages xii+573. 14.5×23 cm. 1951. John Wiley and Sons, Inc., 440 Fourth Avenue, New York 16, N. Y. Price $10.00.

Fourteen specialists have contributed the chapters of this volume and have provided long desired information concerning the Pacific and its scattered lands. The Geographic Setting of the Pacific by Dr. Freeman serves as an introduction, followed by chapters on The Native Peoples of the Pacific; Exploration and Mapping of the Pacific; Australia; Northern and Eastern Melanesia; The Mariana, Volcano and Bonin Islands; The Caroline Islands; Micronesia; The Philippine Islands; Hawaii and American Outposts; Eastern Polynesia; Central and Western Polynesia; New Zealand; Indonesia; The Kuril and Ryukyu Islands and Islands of the Eastern and Northern Pacific. The concluding Chapter deals with Trade, Transportation and Strategic Location in the Pacific. The book is well illustrated and amply provided with Maps, Tables and Bibliographies.

VILLA B. SMITH

GEOGRAPHY AND WORLD AFFAIRS, A Book of the Rand McNally Social Studies Series, by Stephen B. Jones, *Professor of Geography, Yale University,* and Marion Fisher Murphy, *Former teacher of Geography.* Cloth. Pages vl+398. 20.5×26 cm. 1950. Rand McNally and Company, Chicago.

This text presents world problems and world relationships in their geographic setting and with their historical background. It is written for junior or senior high school students and should create real interest and lead to an intelligent understanding of the world political pattern.

Numerous maps—political, physical and economic—and photographs are an essential part of the text material. Thirty-eight well chosen cartoons give additional political information. Each chapter is followed by A Workshop in which activities are directed and information checked. One section—How Do You Feel About It?—calls for an expression of opinion based on facts.

The text is organized in seven chapters, the first being About People and Politics, and the last, Its All One World. The intervening chapters present The Soviet Union, The Western Coastlands (Europe and Africa), The Eastern Coastlands (Asia), The Oceans in World Affairs, Politics and the New World. The United States is presented last, the student now being able to understand his homeland and its political problems and to relate them to the world political pattern.

The text presupposes an adequate background in geography. It presents a new and different viewpoint and should challenge students ready for its mastery. It furnishes a foundation for the understanding of later courses in World and United States History.

VILLA B. SMITH

OUR ECONOMIC WORLD, by Wallace W. Atwood and Ruth E. Pitt, *Social Studies Department, East High School, Buffalo.* Cloth. Page viii+529. 15.5×23 cm. 1950. Ginn and Company, Boston.

The six divisions of this text indicate the organization of its subject matter: Part I, The Physical World; Part II, Peoples of the Earth; Part III, Economic Resources of the World; Part IV, Trade With Our Neighbors; Part V, Economic Services and Responsibilities; Part VI, Work and Workers in Our Economic World.

The text is well illustrated and provided with black and white maps and graphs. The Appendix provides problems and activities for each Unit of Work, and a list of books for reference reading. Each chapter has special questions and suggestions for things to do.

High School students using this book will acquire a world understanding and through acquaintance with the peoples and resources of the world, have an appreciation of the interdependence of peoples.

VILLA B. SMITH

THE PRINCIPLE OF RELATIVITY—A Collection of Original Memoirs on the Special and General Theory of Relativity, by H. A. Lorentz, A. Einstein, H. Minkowski and H. Weyl. Notes by A. Sommerfeld. Translated by W. Perrett & J. B. Jeffery. 216 pages. 5⅜×8. Paperbound $1.50. Clothbound $3.50. Dover Publications, Inc.

Nature, the noted English science magazine, writes:

"Clearly the collection is a very representative one and is certain to prove useful to the English student of Relativity. . . . The fundamental papers of Lorentz and of Einstein no doubt need no mention here, as they will be sufficiently well known to physicists; attention may, however, be drawn to the valuable notes by Sommerfeld appended to Minkowski's lecture.

"The remaining four short papers by Einstein are of great interest, especially the last two. The first of these gives the theory of Einstein's finite cylindrical world; the second . . . propounds a theory of the constitution of matter . . . .

"In the last paper of the collection Weyl gives a sketch of the general principles of his theory of the gravitational and electromagnetic field.

"The present translations are excellent, accurate and idiomatic; the printing is clear, even as regards small suffixes, and is remarkably free from misprints. Altogether, the book constitutes an indispensable part of a library on relativity."

It is really a thrill to read again the *original* papers by these giants—I say original, although strictly speaking this is not so. The *original* was a German collection under the title "Des Relativitats-prinzip" (Teubner, 1922). But this very excellent translation puts the reader close to the minds of the original authors. Present day students would do well to heed the style and the linguistic temper of these papers. These men could write. Consider this sentence by Einstein: "The results of the previous investigation lead to a very interesting conclusion, which is here to be deduced."

Or this one: "In a memoir published four years ago I tried to answer the question whether the propagation of light is influenced by gravitation. I return to this theme, because my previous presentation of the subject does not satisfy me, and for a stronger reason, because I now see that one of the most important consequences of my former treatment is capable of being tested experimentally."

Or this one by Minkowski: "The views of space and time which I wish to lay before you have sprung from the soil of experimental physics, and therein lies their strength."

Nowhere can a dollar and a half bring such infinite pleasure to the serious student of physics; indeed, students in all quarters would find the investment profitable.

JULIUS SUMNER MILLER

ELECTRICAL COMMUNICATIONS EXPERIMENTS, by Henry R. Reed, T. C. Gordon Wagner, George F. Corcoran, *all of the Department of Electrical Engineering, University of Maryland*. 458 pages. John Wiley. $6.75.

This book is more than a laboratory manual—it incorporates other useful information that makes the experimental work more meaningful . . . it contains data on uncertainties in electrical measurements, on records, reports and interpretation of experimental data, and on graphical symbols . . . it includes

laboratory lectures (on theoretical discussions) along with the step-by-step procedure for laboratory work.

Providing instructions for 60 experiments on D-C fundamentals, A-C fundamentals and long lines, engineering electronics, and radio engineering, *Electrical Communications Experiments* is flexible in that it can be easily adapted to a variety of courses. It is the only book covering a wide range of experiments from sophomore through senior level.

Practically all the experiments given here can be performed with standard measuring equipment and conventional components. Rationalized mks units are used throughout the theoretical development.

This volume embodies all the excellent essentials of a laboratory manual together with a sensible measure of theoretical analysis.

JULIUS SUMNER MILLER

PRINCIPLES OF RADIO, Sixth Edition, by Keith Henney, *Consulting Editor, "Electronics," Fellow, Institute of Radio Engineers*, and Glen A. Richardson, *Assistant Professor of Electrical Engineering*, Iowa State College. Cloth. Pages vii+655. 13.5×21.5 cm. 1952. John Wiley and Sons, Inc., 440 Fourth Avenue, New York 16, N. Y. Price $5.50.

This is the sixth edition of a textbook widely and favorably known in the field of radio. The authors state that it is a complete overhaul of the preceding edition. The book consists of 24 chapters, the first 9 of which are concerned with general principles of electricity, both direct and alternating. Chapter 10 deals with vacuum tubes in general while the next 5 chapters give more detailed explanations of the chief functions of vacuum tubes as rectifiers, amplifiers and oscillators. Three chapters treat more specific applications in the field of radio communication, including such topics as amplitude, frequency and phase modulation, antennas and antenna arrays, transmission lines and coupling systems. Ultra-high frequency and microwave phenomena are treated in another chapter. Chapter 21 is devoted to electronic measuring and service instruments, including vacuum tube voltmeters and cathode ray oscillographs. The final chapters deal with our system of television, pulse transmission and its use in radar, shoran and loran.

The subject matter is well organized, leading the reader in logical steps from the simpler fundamentals to the more complicated applications. The language is clear, concise and not unduly technical. The authors seem to have taken care to explain new technical terms as they occur in use. This is distinctly a textbook, entirely unlike the many handbooks in radio now available. Emphasis is on fundamental principles throughout; detailed instructions for constructing apparatus and the size of various component parts are not found in this book.

The many figures are excellent line drawings of schematic circuits, block diagrams, characteristic curves and similar sketches. Conventional engineering symbols are used in the sketches, which are well and clearly labeled.

The authors have generally used about as simple mathematics as could be employed. The exponential method of writing numbers is stressed. Trigonometry is used in the treatment of alternating currents but an introduction to trigonometric functions is included in the text. Vector methods of dealing with alternating voltages and currents are treated.

An especially commendable feature of this book is the wealth of practical numerical problems found in each chapter along with a careful step-by-step analysis of representative examples. Answers to problems are not given in the book.

The text is remarkably free from typographical errors. A few of the definitions may be open to question, e.g. that of the joule on page 124. In a few cases the situation seems to be over-simplified. For example, a student attempting to balance an inductance bridge by the method described in Art. 5.10 would probably encounter difficulty because he has neglected the necessary resistance balance.

High school students, amateur radio operators and others who have a real interest in radio will be able to acquire an excellent foundation in this field with the aid of this textbook. I would enjoy an opportunity to use this textbook with a group of enthusiastic high school or beginning college students.

WALTER G. MARBURGER
Western Michigan College of Education
Kalamazoo, Michigan

NEW TELEVISION STATIONS TO BE BUILT FARTHER APART

Hundreds of new television stations will probably be built throughout the country within the next decade or two. Those operating on the same channel will undoubtedly be placed farther apart than such stations built in the past.

The increased distance between television stations results from the fact that broadcasts can be seen and heard much farther than the line-of-sight distance originally estimated. Broadcasts from stations too close together interfere with each other and the two programs are superimposed.

Radio experts for several years have been striving to determine just why VHF (very high frequency) and microwave radio waves are nearly always heard even when the broadcasting station is well below the horizon. Their experiments and theories were presented and discussed in a hot session at the joint meeting of the International Scientific Radio Union and the Institute of Radio Engineers.

Those reporting on their researches were Dr. Thomas J. Carroll of Massachusetts Institute of Technology, Dr. Joseph Feinstein of the National Bureau of Standards, Martin Katzin of the Naval Research Laboratory, and L. J. Anderson and J. F. Colwell of the Navy Electronics Laboratory.

These and other experts in the theoretical field do not agree as to why or how the upper atmosphere reflects these radio waves well beyond the horizon. The three most-generally accepted explanations are:

1. Radio waves are scattered by winds and other movement in the upper atmosphere.
2. Roughness of the earth's surface is responsible for some wave scattering.
3. Radio waves are reflected not just by the atmosphere's "radio roof," but also by the gradual change in the density of the upper atmosphere.

REAL BROKEN HEART FROM HIGH BLOOD PRESSURE

The type of person likely to suffer an actual broken heart was described by Drs. Stanford Wessler, Paul M. Zoll and Monroe J. Schlesinger of Boston at the meeting here of the American Heart Association.

He, or she, is the kind of person who has high blood pressure or makes excessive exertion and suffers a particular kind of heart damage.

They made a careful study of 20 broken hearts, or ruptured hearts to use the medical term. The causes they found had no apparent connection with the romantic or sentimental causes popularly said to break hearts.

Rupture, or break, of the heart usually comes, they found, between the fourth and eleventh day of an acute attack of the kind of heart damage called myocardial infarction. This means an area in the heart muscle has solidified and died from anemia because of obstruction of the blood supply to that area.

When a heart blood vessel gets an acute block and infarction develops across the heart wall in a region poorly supplied by other blood vessels and unprotected by scar tissue, the groundwork is laid for rupture. But even with this ready-to-break state, the heart may not break unless high blood pressure or excessive effort occur during the acute infarction. The reverse is also true, the doctors found. High blood pressure and excessive effort do not produce rupture unless the heart has already suffered the damage readying it for a rupture.